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An Analysis of U.S. Navy Humanitarian Assistance and Disaster Relief Operations

1 June 2011

by

LT Cullen M. Greenfield, USN and

LT Cameron A. Ingram, USN

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LIST OF ACROYNYMS AND ABBREVIATIONS

AOR	Area of Responsibility
ARG	Amphibious Readiness Group
CCDRs	Combatant Commanders
CCSP	Combatant Command Support Program
CJCS	Chairman of the Joint Chiefs of Staff
CNO	Chief of Naval Operations
COCOM	Combatant Command
CONPLAN	Concept Plan
CRD	Commander’s Required Date
CRED	Centre for Research on the Epidemiology of Disasters
CSG	Carrier Strike Group
DDG	U.S. Guided Missile Destroyer, Arleigh Burke Class
DEPORD	Deployment Order
DoD	Department of Defense
DoN	Department of the Navy
DoS	Department of State
DR	Disaster Relief
DSCA	Defense Security Cooperation Agency
EM-DAT	The International Disaster Database
ESG	Expeditionary Strike Group
FAA	Foreign Assistance Act
FEMA	Federal Emergency Management Agency
FUNCPLAN	Functional Plan
HA	Humanitarian Assistance
HADR	Humanitarian Assistance and Disaster Relief
JCOA	Joint Center for Operational Analysis and Lessons Learned
JCS	Joint Chiefs of Staff
JFCOM	Joint Forces Command
JOPES	Joint Operation Planning and Execution System
JTF	Joint Task Force
LHA	Landing Amphibious Assault Ship, Tarawa Class
LHD	Landing Amphibious Assault Ship, Wasp Class
MAGTF	Marine Air-Ground Task Force

MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MOE	Measure(s) of Effectiveness
MSC	Military Sealift Command
NECC	Navy Expeditionary Combat Command
NOAA	National Oceanic and Atmospheric Administration
NGO	Non-Governmental Organization
NWDC	Navy Warfare Development Command
OPLAN	Operation Plan
OPORD	Operational Order
OTW	Other Than War
PSU	Port Security Unit
RFF	Request for Forces
SAMM	Security Assistance Management Manual
SAR	Search and Rescue
SECDEF	Secretary of Defense
SITREP	Situational Report
TACMEMO	Tactical Memorandum
TPFDL	Time Phased Force Deployment List
UIC	Unit Identification Code
USAF	United States Air Force
USAID	United States Agency for International Development
USCG	United States Coast Guard
USFFC	United States Fleet Forces Command
USMC	United States Marine Corps
USN	United States Navy
USNS	United States Naval Ship (MSC)
USS	United States Ship (U.S. Navy)
UTC	Unit Type Code

I. INTRODUCTION

A. BACKGROUND

On Tuesday, January 12, 2010, at 4:53 p.m. Eastern Standard Time, Haiti suffered a catastrophic, magnitude-7.0 earthquake that lasted 35 seconds. Its epicenter was near the town of Léogâne, approximately 16 miles west of Port-au-Prince, Haiti's capital, as shown in Figure 1 (Aymat, 2010). By January 24, at least 52 aftershocks measuring magnitude 4.5 or greater had been recorded. The earthquake left over 200,000 dead, over 250,000 injured, and over 1.1 million homeless (Aymat, 2010).

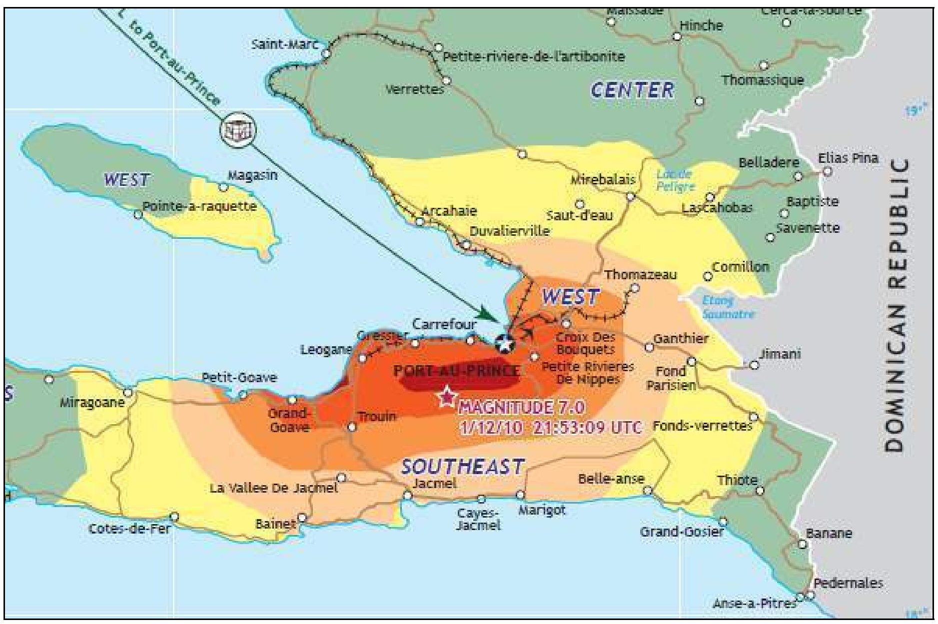

Figure 1. Haiti Earthquake Epicenter and Effective Range
(Aymat, 2010)

Such disasters call for large, fast, coordinated response efforts. In support of the earthquake, the U.S. Navy deployed over 29 ships, including USNS *Comfort* (a hospital ship), six U.S. Coast Guard vessels, two Amphibious Readiness Groups (ARGs), two Marine Expeditionary Units (MEUs), Navy Expeditionary Combat Command (NECC) personnel, and a Port Security Unit (PSU). This is just one of the most recent examples of the U.S. Navy's increasing involvement in disaster relief efforts around the world (Department of the Navy [DoN], 2010).

For the Navy, there are difficulties unique to disaster response that stem from the dynamic nature of the operations as well as the use of military forces for what has historically been a nontraditional mission set. It is difficult to predict exactly where the next disaster may strike, and it is equally difficult to predict the magnitude of any given disaster. In addition to the uncertainty that disasters present, humanity is also facing a world in which the number of disasters reported each year is increasing. Figure 2 shows the increase in reported disasters from 1975–2009.

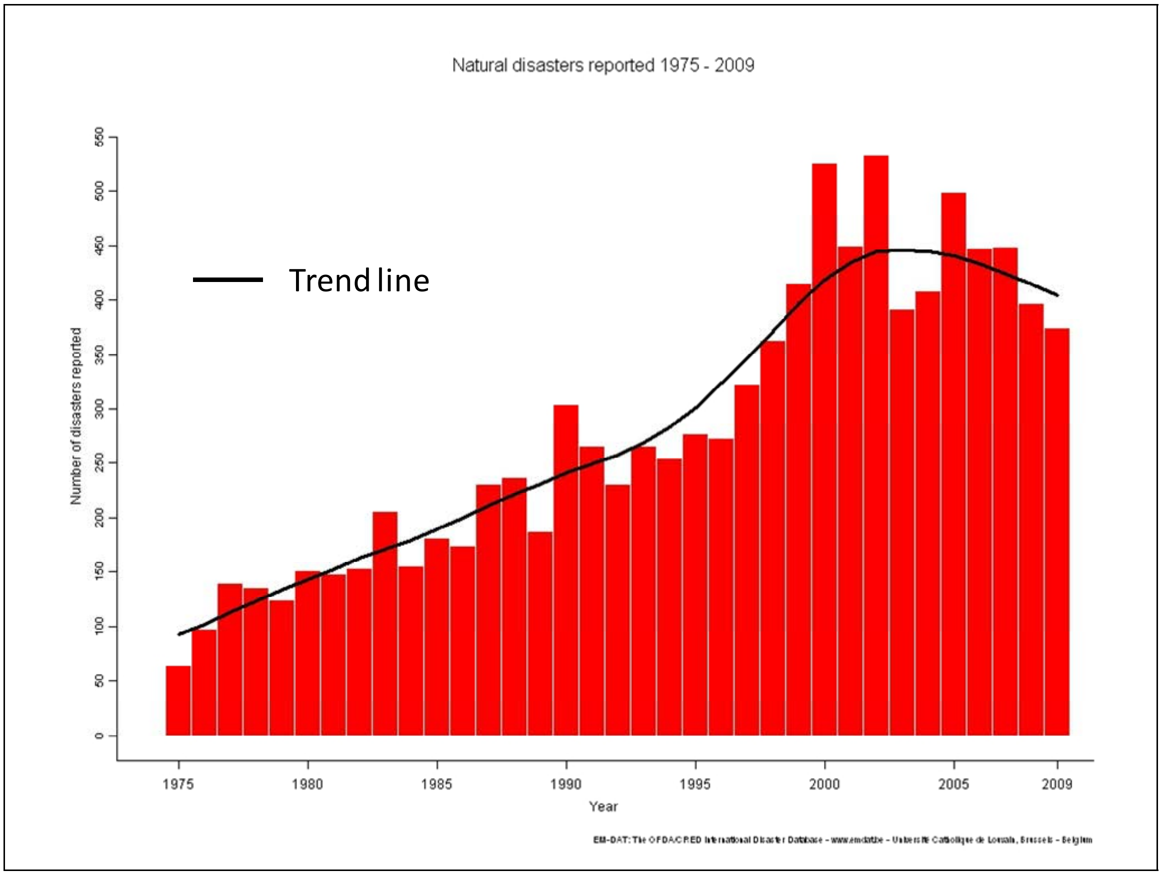

Figure 2. Natural Disasters 1975–2009
(EM-DAT, 2011)

The causes of the increase in disasters include an increase in population, resulting in a larger spread of the populated areas, and an increase in the reporting of smaller disasters. The unique difficulties that disasters pose, combined with the increase in their frequency, make it imperative that the Navy continue to sharpen its level of preparedness and organization.

The Department of Defense (DoD) has been involved in disaster response in the past, but now it has decided to take a leading role in disaster response efforts throughout the globe and, as a result, has become a leader in initial response efforts. As a major component of the DoD, the U.S. Navy (USN) has assumed a large portion of the responsibility. Through the use of surface ships, the DoD can quickly deploy high quantities of relief aid to affected areas in a matter of weeks. The supply line power that the USN possesses is essential in reducing the post-disaster turmoil and easing the "gap of pain"[1] (Cuculo, 2006). The gap of pain refers to the time period between when domestic relief efforts are exhausted and when outside relief efforts arrive. The goal for the DoD, and specifically the USN, is to at least reduce, if not close, this gap of pain by having ready ships on standby in nearby areas. The USN refers to its relief operations as humanitarian assistance and disaster relief (HADR) operations.

A growing interest in HADR efforts from Secretary of Defense Robert Gates (2010) and Chairman of the Joint Chiefs of Staff (CJCS) Admiral Mike Mullen (2007) calls for an in-depth analysis of past disaster relief efforts to improve future relief efforts. Admiral Mullen (2011) recently directed military leadership to focus on developing response capabilities to handle problems created by increasing populations in coastal areas and the weak abilities of Third World countries to respond to natural disasters. As part of a U.S. collaboration to exercise control over the high seas, the USN, the U.S. Marine Corps (USMC), and the U.S. Coast Guard (USCG) have joined efforts to support a variety of missions to include HADR (DoN, 2010). The DoD's recognition of the importance of maritime efforts in HADR operations is evidenced in the following statement by Admiral Arleigh Burke, USN (15th CNO):

> For in this modern world, the instruments of warfare are not solely for waging war. Far more importantly, they are the means for controlling peace. Naval officers must therefore understand not only how to fight a war, but how to use the tremendous power which they operate to sustain a world of liberty and justice, without unleashing the powerful instruments

1 The term *gap of pain* was borrowed from a PowerPoint briefing given by Army Brigadier General Anthony Cuculo on the lessons learned from Hurricane Katrina. Brig Gen Cuculo is the Commander of the Joint Center for Operational Analysis and Lessons Learned (JCOA), a subordinate organization of U.S. Joint Forces Command (JFC), Joint Center for Operational Analysis (JCOA Report).

> of destruction and chaos that they have at their command. (DoN, 2010, p. 43)

HADR operations have become the leading other than war (OTW) mission executed by the USN. Over the past decade, the USN has been essential in the relief efforts of the Haitian earthquake, the Indonesian tsunami, and Hurricane Katrina, to name a few. Its involvement has helped provide millions of tons of medical supplies and food, gallons of fresh water, and personnel to assist those affected by the disasters. While these examples can be viewed as a success, there have been instances where the Navy could have performed better. On November 15, 2007, Bangledesh was ravaged by Cyclone Sidr, the equivalent to a Category 5 hurricane, which caused over 10,000 deaths and over $450 million in damages. In response, the USN decided to send one of its Guided Missile Destroyers (DDG), which was in the vicinity and on which one of this study's authors, LT Ingram, served. The problem the DDG had was its inability to get within close range of Bangledesh. Due to draft constraint and the gradual slope of the Bangledesh coastline, the DDG could approach no closer than 25 miles from the shoreline, out of visible range. In addition to the distance restrictions, the DDG was not outfitted with a helicopter; it could not produce enough water to supply victims or hospitals ashore; it did not have excess food or medical supplies to provide; and, ultimately, it had no way of assisting the devastated country. It was not until two days later, when a Landing Amphibious Assault Ship (LHA) arrived on station, that the USN could provide HADR support.

Combatant Commanders (CCDRs) are required to juggle time, space, and force considerations to execute all missions, and the uncertainty of the environment and requirements of HADR operations only increases the complexity of the planning and response process (Preston, 2010). As illustrated in the previous paragraph, the USN has often been very responsive in an effort to provide HADR support; however, there are several lessons learned and improvements that can be made to the process. In the future, the USN plans on becoming more involved in HADR operations, according to Bruce A. Elleman, a naval historian:

> During the nineteenth and most of the twentieth centuries, the very thought that sea powers might regularly use naval platforms to deliver

> humanitarian aid, as opposed to cutting off and starving an enemy's supply lines, would have seemed alien. In the twenty-first century, however, national power and prestige are more and more characterized by "soft power." UNIFIED ASSISTANCE showed that "hard power" assets like aircraft carriers can also be the best providers of "soft power." (2007, p. 45)

To become more effective in HADR operations, the USN will need to understand what asset will be best in responding to specific disasters. The assumption that the closest asset is best will not lead to a suitable or effective utilization of resources. There must be a systematic approach to the method in which assets are deployed in support of the HADR mission.

The USN is a global leader in disaster relief efforts, particularly because it owns multiple assets that have several capabilities that are unique and extremely useful in relief efforts. Beyond asset capability, the validity of the mission helps to "solidify existing partnerships with key nations and open access to new relationships between and among nations, non-governmental organizations, and international organizations" (Stavridis, 2010). The largest benefit that the USN provides is the ability to traverse the sea. With a large number of the world's population living in close proximity to the coastline, the USN has the ability to access these areas better than any other service or agency. The size and funding of the USN makes it the leading U.S. organization to take on disaster relief efforts. HADR is a dynamic and unpredictable mission that the USN conducts, which poses a large scale of difficulty.

B. PURPOSE AND RESEARCH OBJECTIVES

Creating a coherent national strategy for dealing with HADR operations requires addressing a variety of issues, including interagency relationships, the role of the military in humanitarian aid, and the delicate link between aid and foreign policy goals (USAID, 2002). The USN has acknowledged HADR competency as one of the core capabilities required for the successful implementation of *A Cooperative Strategy for 21st Century Seapower* (DoN, 2007), adopted by the leaders of the USN, USMC, and USCG. The main purpose of this project is to gain more insight with respect to which USN and Military Sealift Command (MSC) assets are best matched to specific disasters. A firm

understanding of this matching will help the USN make more effective decisions in planning and executing HADR operations throughout the world.

Although this project is useful to the DoD in its ability to prepare for and conduct HADR operations, this project does have limitations in its scope. The main limitation of the project is its inability to predict the nature or frequency of disasters. The unpredictable nature of disasters is what poses the greatest challenge to the HADR process. Without the knowledge of when or where a disaster may occur, it becomes difficult to predict needs and dedicate assets. While engaged in two overseas wars and numerous operations throughout the world, the USN and MSC face difficulties in setting aside assets as "standby" units waiting for a disaster to occur. While the frequency of global disasters is increasing, where and when disasters may occur is still to a large extent uncertain. The goal is to determine which U.S. Navy assets are best suited for a specific disaster, based on the uniqueness of the disaster and capabilities and limitations of the assets. Knowing the best possible asset to assign to a disaster will improve the DoD's effectiveness in regaining stability, both monetarily and logistically, within the affected region as disasters occur, and knowing which assets are best suited for disaster response will help the USN with future force structure and fleet composition. Above all, we hope to improve the HADR process in order to alleviate some of the hardship that is brought on by disasters.

C. METHODOLOGY

In this thesis, we examine the history of HADR operations, noting the characteristics of the disasters and, more importantly, the response to the disasters. By studying the *response*, we hope to understand the organization in the response. We identify those naval assets that were deployed as part of the response and evaluate whether the asset deployed had capabilities that were well matched to the disaster type and its effects. In this project, we did not look for the reason that a certain asset was sent; rather, we strictly input the raw data of the assets that were sent. Additionally, we gathered historical data from three significant and recent disasters and compiled it into multiple matrices in order to gauge the effect of the disasters and response to the same. The data was collected on the following disasters:

- Indian Ocean tsunami (2004),
- Hurricane Katrina (2005), and
- Haiti earthquake (2010).

Data collection was comprised of the following information:

- Disaster types and characteristics,
- Specified disaster intensity/scale,
- Effects on the local population and infrastructure,
- Humanitarian aid requested/needed,
- Identification of standard HADR missions and operational requirements,
- Asset deployment in HADR operations,
- Duration of USN HADR operations,
- USN and MSC platform characteristics, and
- Platform capabilities and limitations in conducting identified HADR missions.

The tables and notes, created from the data we gathered, helped us discover unique and specific circumstances in operations. The tables and notes also allowed us to determine asset utilization, effectiveness of the mission, lessons learned, and improvements to the process, as well as limiting factors (e.g., physical or political barriers) to a specific disaster.

The next step in this research process was to classify disasters and search for patterns. The goal was to determine whether any patterns existed in response effort utility. We discuss all patterns of utility that exist in the analyses and conclusion of the project. In addition to discussing discovered patterns, we make recommendations as to platform utility for certain disaster characteristics. If patterns did not exist, we performed a cause and effect analysis of the responses to the disasters and determined if improvements could be recommended. We have compiled what we determined to be the most important aspect of a disaster, and we make recommendations on how to best address these disasters in the future. We also make recommendations on how to further develop the research or situational awareness of HADR operations by discussing the limitations of the project.

D. ORGANIZATION OF REPORT

This study is broken down into six chapters. Chapter I is the introduction and background, where we described the motivation for the research, objectives, and

methodology and provided a brief overview of the current situation and a layout for the remainder of the report. In Chapter II, we review the literature on U.S. Navy responses to HADR. In Chapter III, we describe the methodology we used for collecting and analyzing data. Chapter IV is a compilation of the empirical data. In Chapter V, we analyze the data we gathered, and this is followed by a conclusion. In the conclusion, we summarize the trends we discovered in our analysis of the gathered data, make suggestions regarding force structure and best practices, and provide recommendations for further research.

II. LITERATURE REVIEW

In order to form a meaningful understanding of the field of HADR, it is first necessary to understand the definitions used in the field. Through a thematic analysis of the literature, we define the field of HADR and then analyze overall trends.

There are a few recurring themes in the literature: difficulties of interagency collaboration, difficulties of military and civil interaction, and the need for further quantitative and qualitative research.

A. DISASTERS

1. FEMA Definition

To understand the USN approach to HADR operations, we must first understand the types of disasters to which it responds. A leading source for disaster information is the Federal Emergency Management Agency (FEMA). According to FEMA, a disaster must result in a minimum of 100 deaths/injuries or result in over $1 million worth of damage (FEMA, 2010). Also according to FEMA, there must be some form of substantial damage or high impact in order for relief efforts to be granted. The nature of disasters can be further analyzed through a data collection such as the International Disaster Database, known as EM-DAT. The EM-DAT website, run by the Centre for Research on the Epidemiology of Disasters (CRED), is an active database that collects pertinent information on every disaster and compiles all the data into one central location (EM-DAT, 2011). Similar to FEMA, the CRED uses specific criteria to determine what events qualify as disasters. At least one of the following criteria must be met for an event to be entered into the EM-DAT database: at least 10 people killed, at least 100 people reported affected, a state of emergency declared, or a call for international assistance made (EM-DAT, 2011). The EM-DAT website also contains numerous graphs, maps, and articles relating to both specific and nonspecific disasters around the world. The FEMA and EM-DAT websites and available Navy records were our source in establishing which disasters we would research and analyze to determine the level of involvement for the USN in the relief efforts.

2. Recent History of Disasters

Access to information on the impact of disasters, such as deaths, injuries, and damage costs, is a relatively new development. Traditionally, information on disasters was gathered at the time of the emergency. The importance of the response effort often outweighed the importance of collecting information, so the quality and quantity of reported disaster information suffered (EM-DAT, 2011).

The severity of the problem posed by natural disasters is obvious; excluding epidemics, from 1974 to 2003, there were 6,367 natural disasters resulting in more than two million deaths and damages of approximately $1.38 trillion. Narrowing the scope of impact, from 1993 to 2003, Asia suffered 75% of the deaths resulting from natural disasters (Guha-Sapir, Hargitt, & Hoyois, 2004). More recent data shows 373 natural disasters recorded in the year 2010 alone, resulting in 296,800 deaths, 207 million adversely affected people, and approximately $109 billion in damage. Even though the Americas suffered 75% of the deaths caused by natural disasters in 2010, Asia suffered almost 85% of natural disaster deaths in the last decade.[2] Of the top ten disasters in 2010, ranked by the resulting number of deaths, six occurred in Asia, three in the Americas, and one in Africa. In the decade from 2001 to 2010, there were four separate years where the death toll from natural disasters exceeded 100,000 people. Examining deaths due to natural disaster reveals that 2010 was the third deadliest year in the last 40 years—exceeded only by 1970, when a major cyclone hit Bangladesh, and 1983, when drought and famine struck Ethiopia (Guha-Sapir, 2011).

3. Disaster Classification

Understanding the nature of HADR requires a consistent definition of both humanitarian assistance (HA) and disaster relief (DR). To reach a common definition for these terms, it is necessary first to define what we mean by disaster. FEMA's definition clearly defines the outcome of a disaster but does nothing to categorize the nature of the

[2] The 2010 earthquake in Haiti caused more than 222,000 deaths, making it four times worse than the next deadliest natural disaster of 2010, a heat wave in Russia, and about 75 times worse than the third deadliest, an earthquake in China (Guha-Sapir, 2011).

event. Analysis of supply chains in humanitarian assistance goes further toward creating an understanding of the nature of a disaster by classifying disasters according to their speed and source (Van Wassenhove, 2006).

Van Wassenhove's (2006) classification structure is useful to logisticians because a more refined description of a disaster captures more of the implications and difficulties that will be faced in the response process. For example, consider the differences between an earthquake and a hurricane. An earthquake frequently provides responders with little to no warning that it will occur, while a hurricane forms far out in the ocean and is tracked by meteorologists for at least days before it strikes land and causes the damage required to classify as a disaster.

While classifying disasters according to onset speed is more useful than simply defining the required outcome, there is still a significant piece of the picture missing. An earthquake in San Francisco could collapse a single building and kill 100 people. This qualifies as a disaster. A famine in Africa is likely to kill more than 100 people and would also be considered a disaster. However, the difference between the two disasters is easy to imagine. A single collapsed building implies that the response efforts would be focused within a space smaller than a city block, while any response to a famine in Africa is likely to span at least the breadth of one whole country.

Apte (2009) refined the classification of disasters beyond the framework suggested by Van Wassenhove (2006). She included the nature of the location of the disaster, localized or dispersed, as well as the onset rate, to provide a more useful structure for classifying disasters to help consider the difficulties that may be associated with aid response (Apte, 2009). Figure 3 shows the link between a disaster's location type, onset rate, and level of difficulty associated with response efforts.

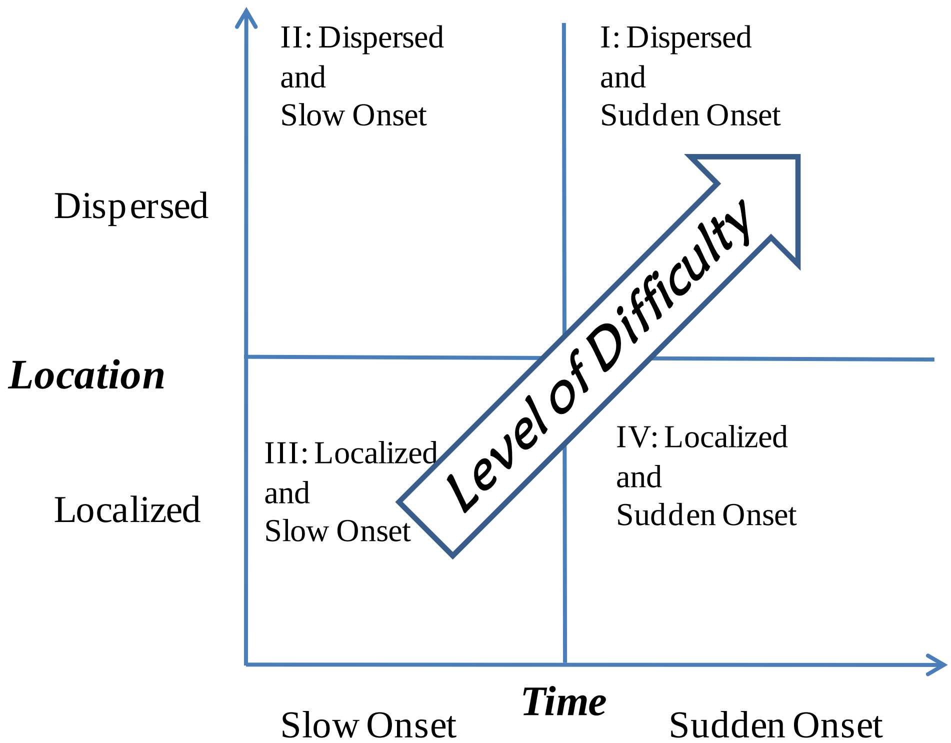

Figure 3. Classification of Disasters
(Apte, 2009)

Where a disaster fits into Apte's framework can clarify some of the challenges planners will face when preparing for relief operations. Localized disasters that strike slowly provide responders with more time to prepare and spread resources across a smaller area, which makes responding to these types of disasters much easier than responding to a dispersed disaster that occurred suddenly (Apte, 2009).

B. HUMANITARIAN ASSISTANCE AND DISASTER RELIEF

The academic literature is fairly consistent with respect to definitions of HA and DR. Both HA and DR include operations designed to relieve suffering due to the occurrence of a disaster and to aid in recovery. There is, however, a difference between the two terms. A variety of academic literature suggests that DR is defined by its immediacy and HA is the provision of more long-term support to help alleviate suffering and aid in recovery (Apte, 2009; Kovacs & Spens, 2007; Tomasini & Van Wassenhove, 2009). The United States' National Security Strategy (Obama, 2010), the National Defense Strategy (Gates, 2008), various military directives (DoN, 2005a; Joint Chiefs of

Staff [JCS], 2009), and the Defense Security Cooperation Agency (DSCA, 2003) all have similar definitions for HA and DR, which they either state explicitly or imply.

1. The HADR Life Cycle

The literature clearly defines the required effect of a disaster in terms of damage and the different aspects of a disaster's nature that allow it to be classified according to the difficulty associated with a response effort. To create a full picture of the field of HADR, we must still consider the framework for analyzing a disaster management effort. Two early but seminal works (Long, 1997; Lee & Zbinden, 2003) provided an easy method of distinguishing between different operations in disaster management. Both works recognize different stages of disaster management, characterized by both when the disaster occurs and when the response effort itself is carried out. Kovacs and Spens (2007) went further by clearly defining the transitions between phases of disaster management. They stated that "different operations can be distinguished in the times before a disaster strikes (the preparation phase), instantly after a disaster (the immediate response phase) and in the aftermath of a natural disaster (the reconstruction phase)" (Kovacs & Spens, 2007, p. 101), as illustrated in Figure 4.

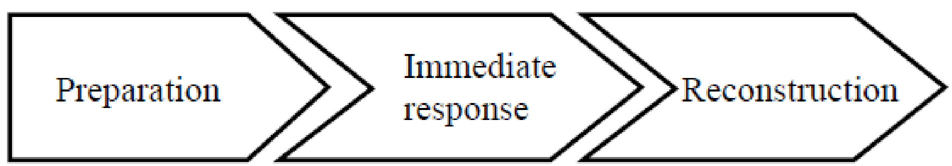

Figure 4. Phases of Disaster Relief Operations
(Kovacs & Spens, 2007)

2. HADR Is Logistics Dependent

Strategists in the field of HADR are primarily concerned with the discipline of logistics. Due to the inherent uncertainty involved in dealing with disaster response, all the standard problems facing commercial supply chains are amplified for HADR operations. Errors in preparation and responsiveness of the humanitarian supply chain have far-reaching and long-lasting effects (Kovacs & Spens, 2007). Discussion of Lee's (2006) *The Triple-A Supply Chain* defined three key features that a supply chain in the

private sector must have for success: it must be agile, adaptive, and aligned (Lee, 2006). Agility is needed to deal with uncertainty and risk, the ability to adapt is necessary in a rapidly changing operational environment, and alignment of the interests of all players in the supply chain is needed for smooth coordination (Lee, 2006). Such features are more difficult within response supply chains.

Oloruntoba and Gray (2006) argued that agility is the critical characteristic most frequently missing from humanitarian aid supply chains. Because goods are generally assigned to a specific destination at their supply chain source (such as when they are donated for a specific disaster relief effort), this introduces inflexibility from the beginning (Oloruntoba & Gray, 2006). Since aid items are typically assigned a destination (consumer) at the very beginning of the humanitarian aid supply chain, the length of the chain itself and the diverse nature of the players inhibit agility. Figure 5 illustrates a typical flow of goods.

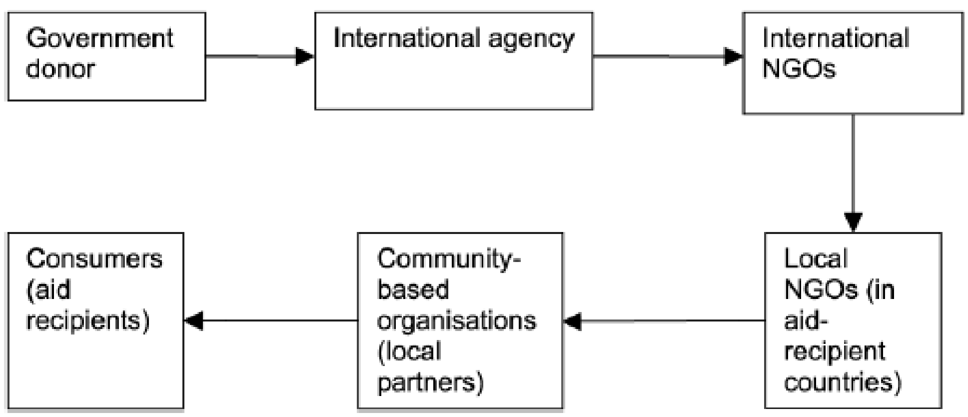

Figure 5. A Typical Humanitarian Supply Chain
(Oloruntoba & Gray, 2006)

3. Challenges Resulting From the Diversity of Actors in HADR Operations

HADR operations typically require contributions from a diverse pool of actors. Non-governmental organizations (NGOs), the DoD, the Department of State (DoS), foreign governments, private citizens, corporations, local partners, and aid recipients are all actors who can play roles in the humanitarian aid supply chain. Lack of agility is not the only problem that actor diversity causes for HADR operations. Problems of trust and

communication (Tatham & Kovacs, 2010), coordination (Lawlor, Kraus, & Kwast, 2008), responsibility handoffs (Pettit & Beresford, 2005; Henderson, 2007), consistent management practices, failure to incorporate lessons learned, inventory management, and information management (Apte, 2009) are just a few examples. Figure 6 shows the complex nature of the humanitarian aid network.

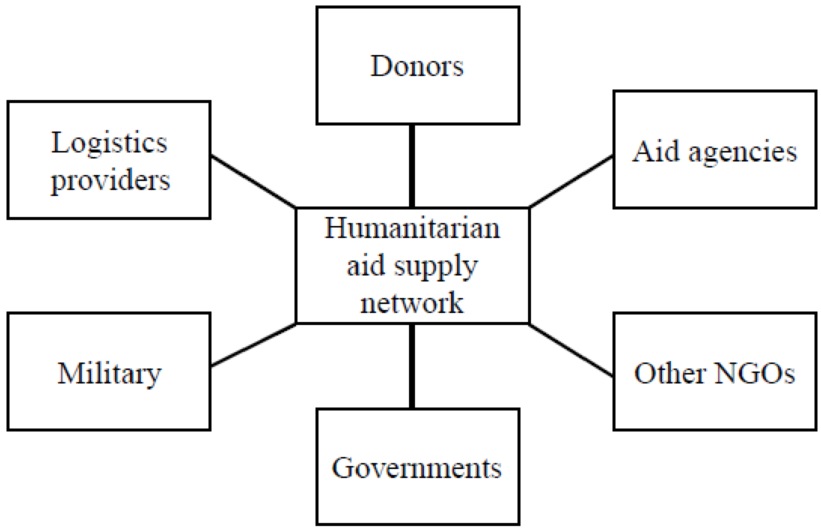

Figure 6. Actors in the Supply Network of Humanitarian Aid
(Kovacs & Spens, 2007)

4. Modeling Disaster Management

There are many models for disaster management and recovery (McEntire, 2006). Considering disaster management from a "big picture" perspective—with only the most basic division between responsibilities, tasks, or phases—allowed us to see potential areas where different challenges might arise and helped us to determine the specific nature of the challenges that could be faced at different times and between different actors. Haas, Kates, and Bowden (1977) put forth an early model that illustrated the different degrees of intensity of different actors in disaster management and the differences between phases of the relief effort over time. This model was later modified by Pettit and Beresford (2005), as shown in Figure 7.

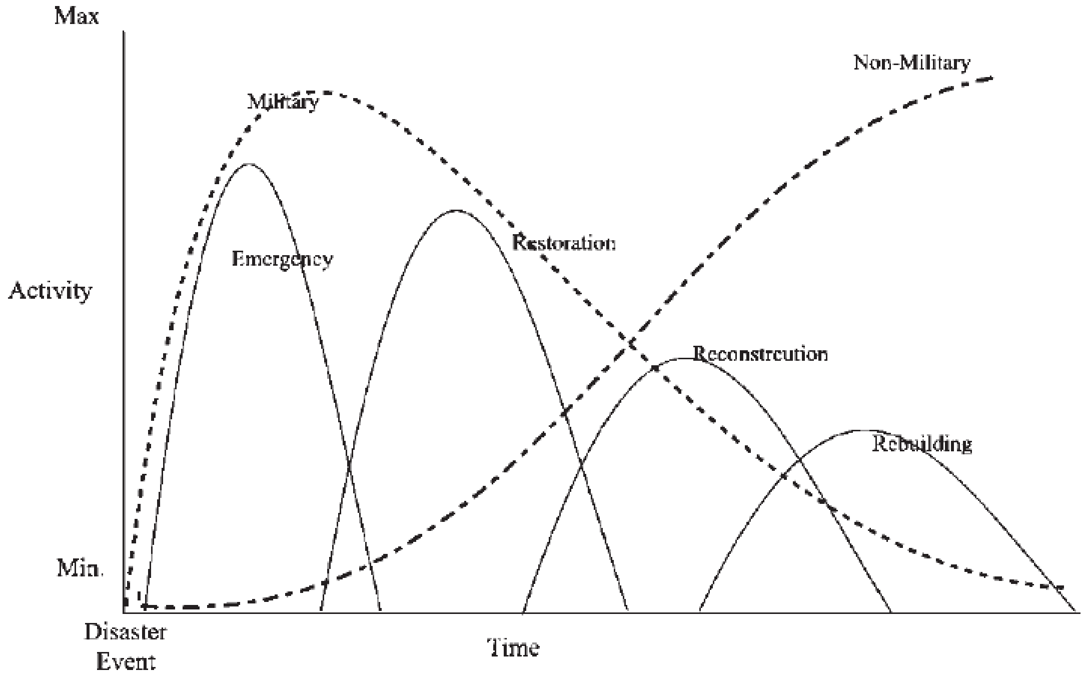

Figure 7. A Model of Emergency Recovery
(Pettit & Beresford, 2005)

Pettit and Beresford's (2005) illustration of activity intensity in a disaster recovery process provides actors such as the military with the ability to easily gain a broad picture of when they will play a key role in the recovery process and what types of activities they will be contributing. The Fritz Institute uses Haas, Kates, and Bowden's model of emergency recovery to create its own illustration of the different phases a supply chain for humanitarian relief undergoes. This illustration is shown in Figure 8 (Thomas, 2003).

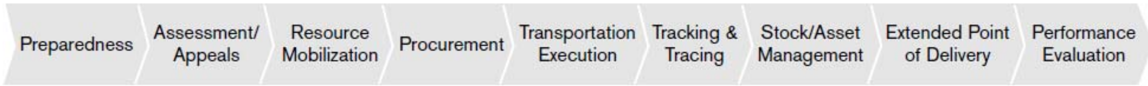

Figure 8. The Supply Chain for Humanitarian Relief
(Thomas, 2003)

Kovacs and Spens (2007) showed the different phases of disaster relief operations; Pettit and Beresford's (2005) model of emergency recovery illustrated different phases for the recovery cycle and levels of activity; and Thomas's (2003) graphic of the supply chain phases showed the cumbersome nature of the supply chain for

HADR operations. These models, as well as Kovacs and Spens (2007), were all narrowly focused on small aspects of relief efforts and did not provide a structure for examining all aspects of HADR operations.

Apte (2009) provided a structure for comparing disaster phases with corresponding logistics activities and time horizons. She also put forth the visual depiction for examining the humanitarian supply chain for the purpose of broad understanding within the context of a disaster time line (reproduced as follows in Figure 9). The Apte (2009) model provided a breakdown of pre- and post-disaster activities, short- and long-term recovery, and distinctive tasks within the different phases of disaster management.

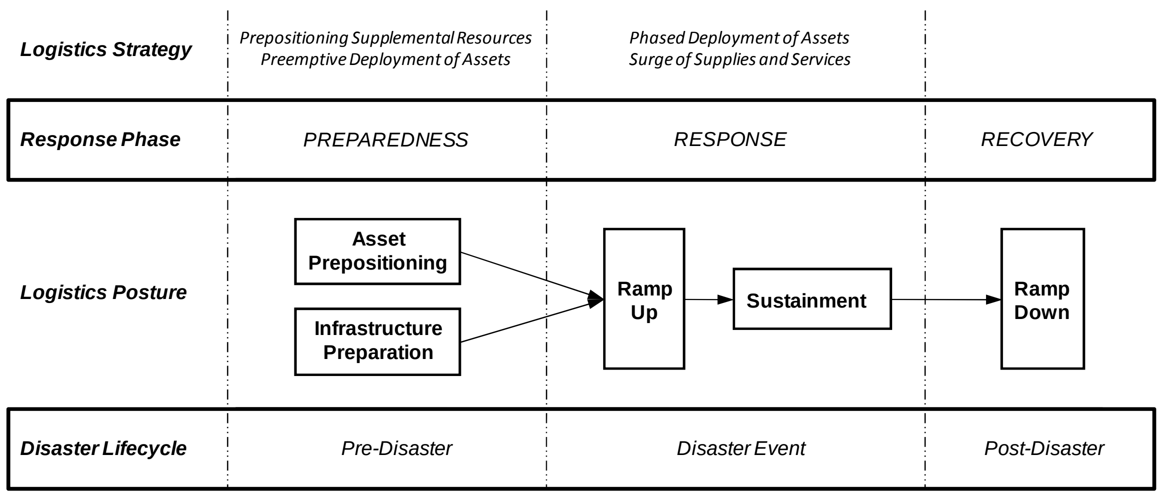

Figure 9. Time Line of the Humanitarian Supply Chain
(Apte, 2009)

C. THE MILITARY IN DISASTER RELIEF OPERATIONS

A Marine Air-Ground Task Force (MAGTF) is a term used by the USMC to describe the principal organization for all missions across the range of military operations. A MAGTF is a balanced air-ground, combined-arms task organization of Marine Corps forces under a single commander and is structured to accomplish a specific mission. A MAGTF with separate air-ground headquarters is normally formed for combat operations and training exercises. The MAGTF contains substantial combat forces of both Marine aviation and Marine ground units included in the task organization

of participating Marine forces (Simmons, 2003). The command structure of a MAGTF is illustrated in Figure 10.

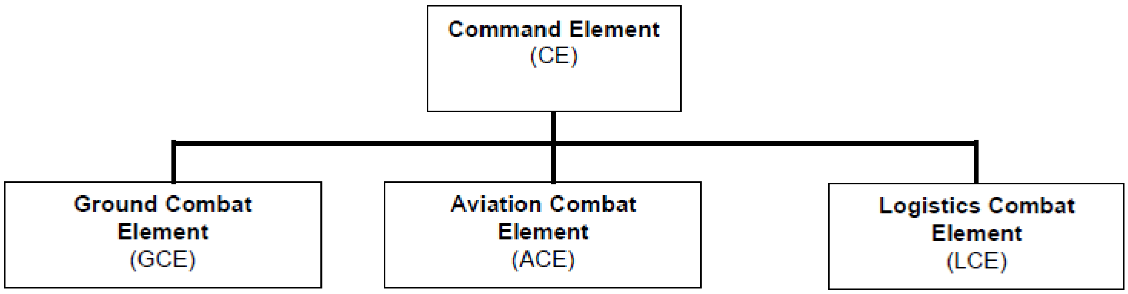

Figure 10. MAGTF Structural Diagram
(USMC, 2011)

A Marine Expeditionary Force (MEF) is a MAGTF that is able to deploy rapidly and conduct operations across the spectrum, from HADR to amphibious assault and high-intensity combat. A MEF comprises a MEF Headquarters Group, Marine Division, Marine Air Wing, and Marine Logistics Group. The three MEFs are as follows:

- I Marine Expeditionary Force, located at Camp Pendleton, CA.
- II Marine Expeditionary Force, located at Camp Lejeune, NC.
- III Marine Expeditionary Force, located at Camp Courtney, Okinawa, Japan.

A Carrier Strike Group (CSG) is an operational formation of the United States Navy. It is composed of roughly 7,500 personnel, an aircraft carrier, at least one cruiser, a destroyer squadron of at least two destroyers and/or frigates, and a carrier air wing of 65–70 aircraft.

An Expeditionary Strike Group (ESG) is a group made up of amphibious ships, cruisers, destroyers, and submarines. An ESG allows Navy and Marine Corps forces to support a variety of operational missions.

1. Background and Influences

On December 26, 2004, an earthquake triggered a tsunami that devastated the southeastern Asian peninsula and surrounding islands. A total of nine countries were directly affected, and thousands of communities were ruined. Within a day, the USN had

ships on station ready to assist the area, launching the largest HADR operation in the history of the USN:

> III Marine Expeditionary Force (III MEF) was designated as the command element for Combined Support Force 536 to conduct Operation UNIFIED ASSISTANCE. Twenty-two U.S. ships, including the ABRAHAM LINCOLN Carrier Strike Group, BONHOMME RICHARD Expeditionary Strike Group, USS ESSEX, USS FORT MCHENRY with a special purpose MAGTF, USCGC MUNRO, USNS JOHN MCDONNELL and six maritime prepositioning ships were diverted from their scheduled routes to render aid that included subsistence, medical support, engineering support, port hydrographic surveys and extensive debris removal. U.S. naval forces did not work in isolation; their immediate response evolved into a multifaceted effort that included other Services, other agencies, the U.S. Agency for International Development (USAID), other countries, nongovernmental organizations (NGOs), and private volunteer organizations. (DoN, 2010, p. 45)

The relief efforts in the South Indian Ocean were just one example of many HADR operations in which the USN has participated over the past 40 years. Between 1970 and 2000, the U.S. has been involved in over 366 HADR missions, which is significant compared to the 22 combat missions that were conducted over the same time period. Specifically, the USN has participated in relief efforts for disasters such as an earthquake in Pakistan, Hurricane Katrina, typhoons in the Philippines, a mudslide on the island of Leyte, a hurricane in Nicaragua, cyclones in Bangladesh, a bridge collapse in the United States, and recently, the earthquake in Haiti (DoN, 2010).

Apte (2009) and the Naval Operations Concept (DoN, 2010) discuss the expansion of the human population globally. As the population expands, people continue to move toward littoral areas, creating a situation in which the risk of a natural disaster affecting these people increases. Because of this phenomenon, there exists an ever-increasing need for the naval forces to respond and conduct HADR operations. In addition, CCDRs have increased their HADR operations to provide an area of responsibility (AOR) that is safer, more stable, and better secured. The view of the DoD is that the HADR operations conducted by the USN not only help those in need but also improve the affected country's political perspective of the United States (DSCA, 2003).

A number of documents address the role of the military in HADR operations. The National Security Strategy, the National Defense Strategy, and the Strategic Plan for the DoS and USAID all outline the importance of HADR operations, both for enhancing the security of the United States and for improving the general welfare of people around the globe (Gates, 2008; Obama, 2010; USAID, 2007). USAID specifically identifies two goals for HADR operations that are well-suited to the military: protection of civilians and alleviation of disaster effects. USAID further recognizes the importance of partnership with the DoD for mounting logistical support for HADR operations (USAID, 2007). Despite the existence of high-level guidance declaring HADR a core mission for the military, the formation of doctrine is still in the early stages. Relatively recently, the Navy released a Tactical Memorandum (TACMEMO) that goes a long way toward establishing hard doctrine for HADR operations, but it still specifically acknowledges the likely existence of tension between an on-scene commander and higher headquarters and of a deficit of training for the mission, both due to the irregularity with which the Navy executes HADR operations (DoN, 2005a).

The Security Assistance Management Manual (SAMM) defines the guidelines for the DoD's Humanitarian Assistance Program and Foreign Disaster Relief and Emergency Response programs (DSCA, 2003). This document covers funding methods, guiding legislation, basic processes, and the request process that is followed to obtain assistance from the United States, as indicated in Figure 11.

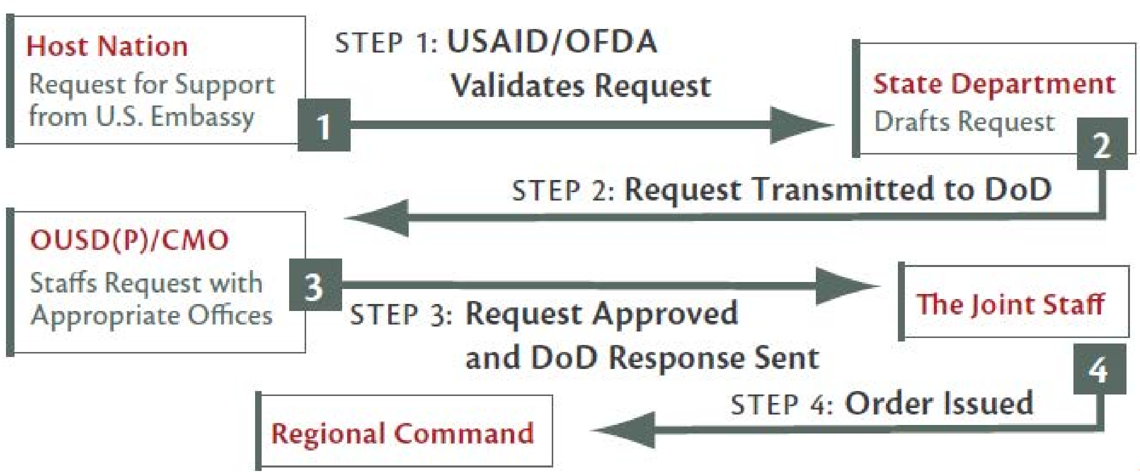

Figure 11. The Executive Secretariat Process
(Perry, Travayiakis, Anderson, & Eisenberg, 2009)

The SAMM "provides guidance for the administration and implementation of Security Assistance and related activities in compliance with the Foreign Assistance Act (FAA)" (DSCA, 2009, p. 2). The SAMM is a governing document for the Office of the Secretary of Defense (OSD), the JCS, CCDRs, and all DoD components engaged in HADR operations (DSCA, 2003). The JCS have provided a publication that reiterates the path of assistance request but also provides more detail regarding the direct management of the DoD's response to a request for aid. Figure 12 documents the interaction of various entities in the decision and management chain.

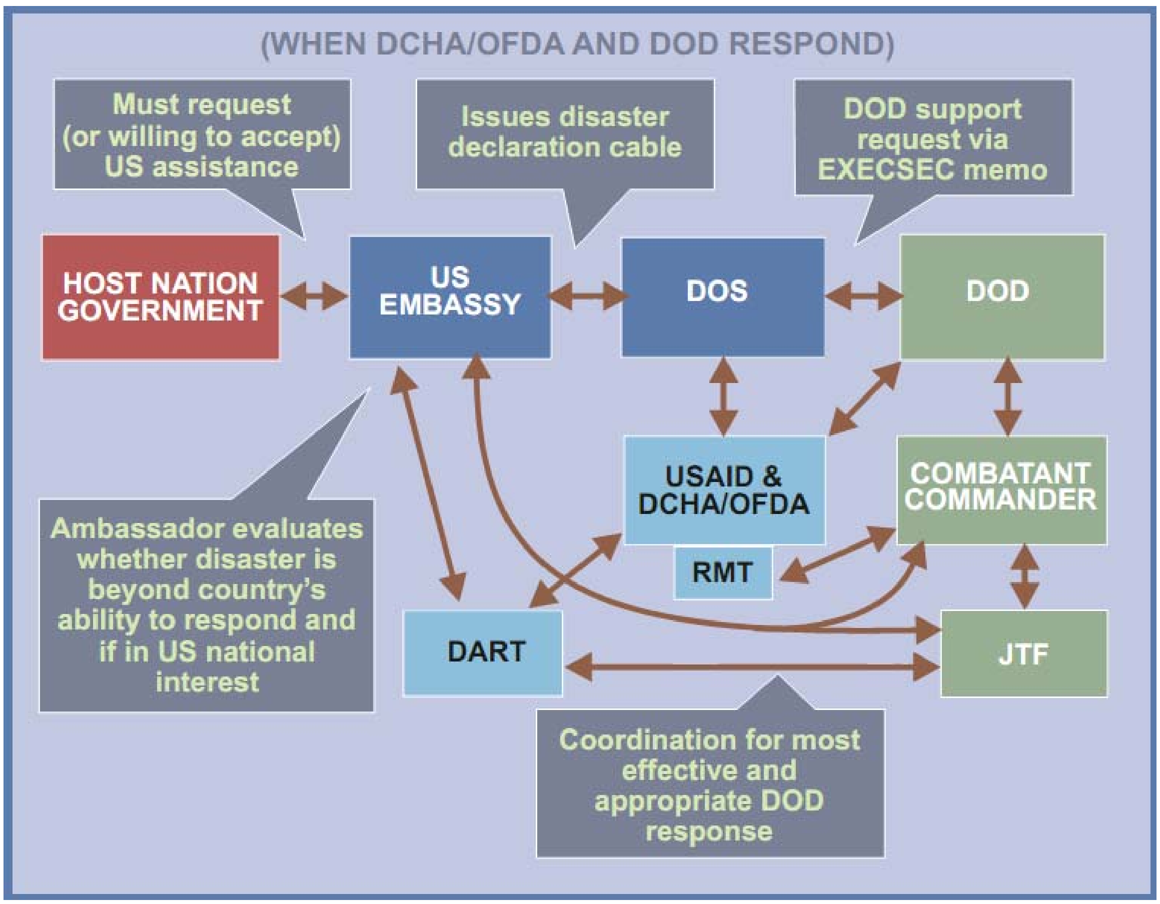

Figure 12. Interagency Coordination Flow
(JCS, 2009)

2. Capabilities and Conflicts

Pettit and Beresford (2005) drew on earlier work (Leaning, Chen, & Briggs, 1999) to create a thorough understanding of the broad capabilities the military offers to the conduct of HADR operations. Though there are numerous capabilities the military brings to the table for conducting HADR operations, there is a limitation. Historically, the military is not intended for conducting disaster relief efforts, and both Pettit and Beresford (2005) and Leaning et al. (1999) argue that this creates numerous conflicts between military actors and the roles they fill in relief efforts. A number of other authors in the field have outlined similar sets of capabilities and conflicts that the military adds to the field of HADR (Byman, Lesser, Pirnie, Bernard, & Wazman, 2000). Figure 13 and Figure 14 are summaries of both capabilities and conflicts that are due to the military's involvement in HADR efforts. The figures were originally compiled by Leaning et al. (1999) and later adapted by Pettit and Beresford (2005).

Security	Establishment of "safe havens". Protection of relief supplies. Maintenance of a credible armed presence to reduce threat of violence
Transport and logistics	Ability to transport personnel and supplies rapidly. Provide an ongoing supply of equipment and materials
Construction and repair	Building or repairing essential infrastructure – roads, ports, airports, railways and storage facilities
Command, control and communications	Sophisticated communications systems. Rapid and complex contingency planning. Central planning and direction capabilities. Basic organisational and communications framework for relief organisations
Medical care	Rapidly deployable medical teams and evacuation systems. Disease prevention and control. Use of field water purification units
Specialised units	Personnel trained to interface between the military and civilian populations. Experts in transportation, business, law, communications, health, policing
Preparedness	Joint training of military and civilian personnel in preparation for, for example, mass casualty situations

Figure 13. Military Operational Capabilities
(Pettit & Beresford, 2005)

Medical care	Military medicine is not necessarily appropriate for humanitarian crises. Supplies readily available to military forces may be inappropriate for refugees and disaster victims, although at the outset of a crisis they may be all that is available
Conflict resolution	Military forces are not well suited to aid long-term redevelopment efforts. The imposition of security by outside military forces may also impede negotiation and conflict resolution
Interaction with other organisations	Military commanders may be unfamiliar with the roles of major international organisations and, conversely, civilians will have little experience of military organisations. There will be differences in strategy, objectives and tactics
Conflict with humanitarian agenda	Using military resources to achieve humanitarian goals creates tension and can undermine the appearance of neutrality of relief organisations
Adequacy of training	Few military officers receive training in disaster relief or humanitarian assistance. There is also likely to be ambiguity over the role of military physicians in complex emergencies in international humanitarian law
Limited commitment to disaster response	The principal mission of the military is to resolve military conflicts and, generally, less effort and fewer resources are devoted to humanitarian aid unless a HA-specific mission is being conducted

Figure 14. Conflict Between the Military and Its Role in HADR Operations
(Pettit & Beresford, 2005)

3. Force Response Methods

There are two principal ways that forces are assigned to HADR operations. If a Time Phased Force Deployment List (TPFDL) exists for an operation, assets may be assigned to the TPFDL and allocated for the operation before the operation begins. The TPFDL exists in the database portion of the Joint Operations Planning and Execution System (JOPES) and provides CCDRs with oversight of asset movements and assignments (Preston, 2010). The other method is through a Request for Forces (RFF). The RFF process is more dynamic than the use of TPFDL and allows CCDRs to request specific asset capabilities directly from the Secretary of Defense (SECDEF). If approved, Joint Forces Command (JFCOM) will source the required assets and alert each asset in a deployment order. With RFF, unlike using TPFDL, there is no single document that details an exact breakdown of the assets assigned to be used in support of an operation (Preston, 2010). Essentially, the TPFDL method involves a concrete understanding of exactly what assets will be used to support an operation, while the RFF method provides CCDRs with an à la carte selection of assets upon request.

Many combat operations are thought through in more detail than HADR operations due to the increased length of the planning time line. As a result, combat

operations follow Operational Plans (OPLANs) that are very detailed and include TPFDL as part of their guidelines. HADR operations are typically viewed as operations impossible to prepare for in such detail and thus are based on Concept Plans (CONPLANs) or Functional Plans (FUNCPLANs), which are less developed and detailed (Commander, USCENTCOM, 2007; Commander, USEUCOM, 2001; Commander, USNORTHCOM, 2007; Commander, USPACOM, 2003; Commander, USSOUTHCOM, 2006). Neither CONPLANs nor FUNCPLANs include TPFDL (Preston, 2010).

4. The Navy's Role

The USN has set HADR as one of its core capabilities (DoN, 2007), ensuring that it is active in both proactive and reactive HADR operations. The USN stays engaged in a proactive manner by conducting missions like Pacific Partnership, deploying the USNS *Mercy* hospital ship to remote areas throughout the South Pacific, and bringing medical aid and supplies while providing free medical procedures for the local populations. The proactive HADR operations are critical in maintaining political and popular support for these countries. While proactive HADR operations are important, they are not our focus in this project. In this project, we take an analytical approach to the reactive HADR operations. Reactive HADR operations refer to the response to disasters as they occur. As part of reactive HADR operations, the USN sends vessels that are in the geographical area and can provide some form of support to the affected region.

From the DoD perspective, the Combatant Command (COCOM) is in charge of directing asset response for HADR operations (Brannman & May, 2009). Once assets are assigned, they are managed primarily at the Joint Task Force (JTF) level (JCS, 2009). One document in particular defines the Navy's role in HADR operations. TACMEMO 3-07.6-05 is used to "guide a commander and staff in the thought process, planning, and course of action development needed to prepare for and conduct foreign disaster relief operations" (DoN, 2005a, p. 1-1). This memorandum covers a variety of topics, including training, information sharing, command and control, and logistics. Logistics is the largest chapter in the memo, providing some insight into the role the Navy envisions for itself in HADR operations. The importance of the logistics capability provided by the

Navy is evident in the text. The chapter carefully defines how to employ MSC assets, focusing on the use of prepositioning stock, sea basing, and water purification capability. All other surface assets are lumped together. Smaller assets are completely disregarded in favor of discussion of employment tactics for large deck vessels, landing craft, and HSVs, which provide great opportunity for sea basing, evacuation and casualty collection, and quick transportation of supplies (DoN, 2005a).

Additional attention is given to the time line in which the Navy will typically conduct HADR operations. Due to the high potential for rapid loss of life immediately following a disaster, the memo gives blanket authority to begin conducting HADR operations even before receiving full approval from higher headquarters (DoN, 2005a). The logistics chapter of the memo also requires early relief efforts be structured to simplify the process of transferring responsibility to NGOs, or the host nation, at the earliest possible point. The Navy's focus on logistics and speed in disaster response matches the model first put forward by Haas et al. (1977) and later adapted by Pettit and Beresford (2005), which depicted rapidly increasing military involvement in HADR operations upon the occurrence of a disaster, then decreasing participation in operations as time progresses.

5. U.S. Navy and Military Sealift Command Resources

The USN's MSC has a multitude of assets and platforms that it can choose from to conduct HADR operations. The capabilities and limitations of these vessels are highlighted in a general overview publication called *Jane's Fighting Ships* (Jane's, 2010), more commonly known as *Jane's*. *Jane's* is an annual publication that acts as an index and reference tool to see what every nation has as a military asset. *Jane's* is part of a series of publications that encompass every piece of hardware that a country's military may have, even including a multitude of civilian assets such as commercial aircraft and communication systems.

The project concentrates on the *Jane's* publication to get general information that will help to shape the matrix development. Specific information provided in the publication includes the physical properties of a vessel, such as size and draft (a

seamanship term describing the depth in the water to which a vessel extends). These specifications will be crucial in determining which assets can respond to certain disasters. As mentioned previously, in Bangladesh, a DDG was sent to respond to a disaster off its coast but was unable to assist due to draft constraints. In addition to physical properties of a vessel, *Jane's* provides insight into berthing size, crew size, fresh water generating capacity, and so forth. All these characteristics will help in the construction and development of the matrix.

Another source for USN and MSC platform characteristics is the U.S. Navy website, which also includes a significant description of the capabilities and limitations of specific vessels. The two sources were contrasted and compared to each other to ensure that accurate data is procured for the matrix.

D. THE CONTEXT OF OUR RESEARCH IN HADR

1. The Gap in Navy-Related HADR Research

There are a number of publications (including JCS, 2009, and DoN, 2005a) that delineate the actions Navy commanders should take when conducting HADR operations. Similarly, there is a significant amount of literature covering academic analysis of different logistical aspects of HADR operations, but there is little that analyzes where exactly the Navy best fits into the picture, how efficiently the Navy performs HADR operations, or which Navy assets should be used for which missions. The Combatant Command Support Program (CCSP) published a report edited by Lidy and Kunder that provided the only direct reference to asset usefulness in HADR operations; however, even this report was vague, specifying only "air transport" as the DoD asset most needed during responses to Hurricane Georges and Hurricane Mitch (CCSP, 2005).

The CCSP report further offers a long list of questions that may be applied to evaluate HADR operations. The questions that might apply to the asset assignment process are adapted in Table 1.

Table 1. Asset Assignment Evaluation Questions
(CCSP, 2005)[3]

Question 1	Are DoD asset assignments directed by discernible, quantifiable Measures of Effectiveness (MOE)?
Question 2	Was the DoD's asset assignment effective, based on the needs of the disaster victims (and considering political and theater pressures on mission assignments)?
Question 3	Were assets assigned in accordance with DoD doctrine or standard procedures? (Does a standard procedure exist?)
Question 4	Was the DoD's choice cost-effective, both in terms of accomplishing the mission at the lowest financial cost and in terms of deploying the assets best suited for the mission?

Not only does the CCSP report offer questions that can be asked to guide the evaluation of the HADR operations, but it also offers reform suggestions for JTFs that will improve HADR efficiency (CCSP, 2005). These reforms include a predetermined asset composition of HADR JTFs and predetermined task unit assignments for HADR (CCSP, 2005).

Prior to the release of the CCSP report in 2005, Thomas (2003) also stated that standardization of efficiency measures is necessary for improving HADR operational efficiency. Thomas recognized that a focus on "knowledge management…metrics, performance measurement and learning" (2003, p. 8) will increase the effectiveness of HADR operations. The key to Thomas's management of knowledge improvement is the ability to pass along decision-making processes during job turnovers, so that so-called corporate knowledge does not run the decision-making process. She submits that actual past performance in similar situations (in this case, similar relief operations) may be used to evaluate future performance when establishing metrics for performance measurement.

Beamon and Balcik (2008) also discussed the performance measurement of HADR operations, although they focus on the supply chain similarities. Beamon and Balcik provide a synthesis of various works in the field to create a composite framework for evaluating the effectiveness, efficiency, and flexibility of HADR operational supply

[3] This table was modified from the CCSP report to remove questions not relevant to the topic.

chains and operational execution processes. Beamon and Balcik also provide a framework for creating a performance measurement system to be applied to the humanitarian relief sector, shown in Table 2, which can contribute to the development of our process for evaluating the Navy's HADR operations.

Table 2. Relief Chain Performance Metrics
(Beamon & Balcik, 2008)

Resource	Output	Flexibility
Total cost (of resources used)	Total amount of disaster supplies (delivered to aid recipients)	Number of individual units of Tier 1 supplies that an organization can provide in time period T_c
Overhead costs	Total amount of disaster supplies of each type (delivered to aid recipients)	Minimum response time
Total cost of distribution (including transportation and handling cost)	Total amount of disaster supplies to each region (delivered to aid recipients)	Mix of different types of supplies that the relief chain can provide in a specified time period
Inventory investment (the investment value of held inventory)	Amount of disaster supplies delivered to each recipient	Number of individual units of Tier 1 supplies that an organization can provide in time period T_c
Inventory obsolescence (and spoilage)	Target fill rate achievement	
Order/setup costs	Average item fill rate	
Inventory holding costs	Stock-out probability	
Cost of supplies	Number of backorders	
Number of relief workers employed per aid recipient	Number of stock-outs	
Number of "value added" hours (the number of direct hours spent on dispensing aid per total number of labor hours)	Average backorder level	
Dollars spent per aid recipient	Average response time (average time between occurrence of the disaster and arrival of supplies)	
Donor dollars received per time period	Minimum response time (minimum time between occurrence of the disaster and first arrival of supplies)	

Our research does not propose specific measures of efficiency or effectiveness. We provide a picture of the "standard" utility provided by the USN and MSC in a HADR operation, which provides a foundation for future research into appropriate measures of effectiveness and efficiency.

Brannman and May (2009) documented the ad hoc nature of HADR operations that results from lack of standardization in the planning and execution process. Brannman and May suggested that standardization of planning and execution would improve efficiency dramatically. Preston (2010) agreed that some standardization is needed but points out that use of the TPFDL method can result in inflexibility of response because changing TPFDL assignments is a very bureaucratic process. Conversely, the RFF process provides the CCDR with more flexibility—in fact, possibly too much flexibility, since "by not having a rigid schedule or list of units, the wrong units may be deployed at the wrong time" (Preston, 2010, p. 9).

Preston argued in favor of creating a hybrid method of force assignment for HADR operations or merging the TPFDL and RFF methods. He theorized that the initiation of a HADR operation requires CCDRs to operate with flexibility but also with guidelines. Such an initial response might be patterned after the RFF process but provide CCDRs with a list of assets they should consider as top priority at the beginning of the response effort. Following the initial response, there should be a more concrete understanding of capability needs and, therefore, more defined asset requirements, following the TPFDL method. Late in the military's response process, Preston (2010) argued that more flexibility would again be required, because asset capability needs will change depending on disaster type, location, and the availability of assets meeting unique capability requirements earlier in the response.

Foreign Humanitarian Assistance (JCS, 2009) and *NWDC TACMEMO 3-07.6-05* (DoN, 2005a) both enumerate capabilities that will likely be needed in HADR operations. They each pay a small amount of attention to defining which capabilities will be needed in which order, and they make little or no effort to define what assets meet specific capabilities. Preston (2010) argued for the creation of what he called an "Initial Deployment Framework," which lays out the capabilities needed, the services and specific assets by Unit Identification Code (UIC) to meet each capability, the Unit Type Code (UTC), and how long after the disaster the capability will be needed, by Commander's Required Date (CRD). A sample is shown in Table 3.

Table 3. Initial Deployment Framework Example
(Preston, 2010)

Capability	Service	UIC	UTC	CRD
Forward Deployed JTF C2 element	US Army	HEADQUARTERS ELEMENT, BRIGADE		C+12
Medical Response Team	USAF	MEDICAL PRIMARY CARE TEAM		C+24
Land-based Rotary Wing Aircraft	US Army	THEATER AVIATION BATTALION		C+36
Ground Transportation	US Army	INFANTRY BATTALION, MOTORIZED		C+72

While such a plan helps to standardize the response process, Preston (2010) acknowledged that an initial deployment framework with the form he has proposed has limited usefulness if it is not based on lessons learned from past operations, current doctrine, and the specific capabilities of assets.

The main purpose of this project is to gain more insight in analysis of which USN and MSC assets are best matched to specific disasters. A firm understanding of this link will help the USN make effective and efficient decisions in planning and executing HADR operations throughout the world, and if needed, help determine appropriate assignment criteria for assets used to support the HADR mission. We have used the suggestions of Thomas (2003) and the CCSP report (2005) as guidelines for developing a framework to evaluate the Navy's role in HADR operations.

III. METHODOLOGY

We collected data from various naval specification publications, disaster research, and historical documents and compiled them into separate tables on various fields. We analyzed these tables for patterns and specific characteristics so we can characterize a typical USN and MSC involvement in HADR response and determine where the military can focus its efforts to improve. In the analysis, we provide conclusions and recommendations about which HADR operations can be more efficient in the future. In the conclusion, we also identify limitations in the research, benefits of the research, and recommendations for more in-depth research, which could be a continuation of this project.

A. DATA COLLECTION

We tabulated the data collection into three primary groups of tables. The tables are broken down into disaster characteristics, time lines of actual USN HADR responses to specified disasters, and USN/MSC platform capabilities to conduct HADR missions. Tabulation of data assists in the assessment of historical responses, development of general disaster recovery mission requirements, and capabilities of USN and MSC platforms to assist in disaster recovery efforts. The end result allows the researchers to identify patterns and determine effectiveness of USN response to disasters. Figure 15 shows the flow of data collection, data analysis, and our project's contribution.

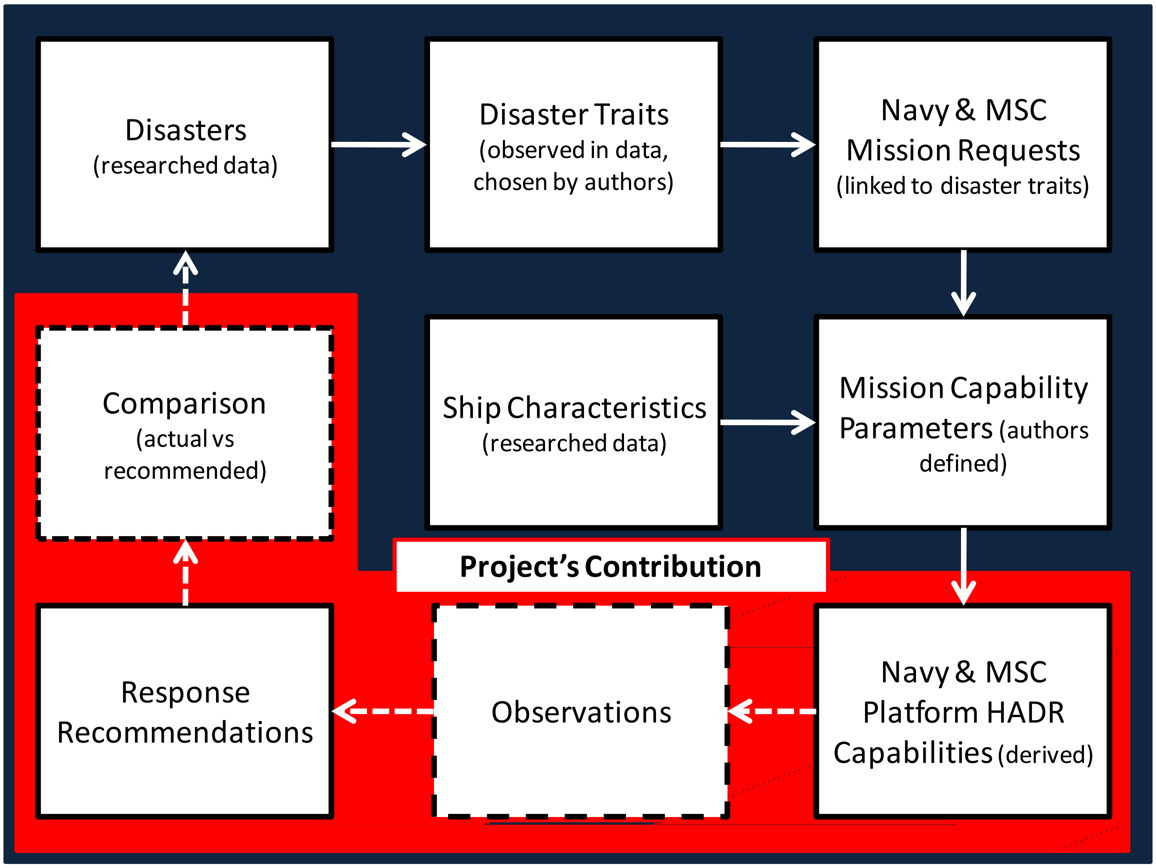

Figure 15. Project Flow Diagram

1. Disaster Traits

Understanding disaster characteristics is important to comprehend future requirements that the USN may be requested to conduct in response to disasters. Determining which basic missions are associated with specific disasters will help in determining which assets are best suited for future HADR operations. Because the U.S. Navy typically plays a larger role in responding to disasters that occur along shorelines, we examined three types of natural disasters that will frequently elicit Navy responses. Hurricanes and tsunamis both inherently involve the ocean, and because earthquakes are a frequent cause of tsunamis, we examine these three types of disaster responses (NGDC, 2011a; NGDC, 2011b). Because this is an analysis of USN HADR response, the only earthquakes that we analyzed were those to which the USN would have the capability to respond, namely coastal-affecting earthquakes.

When researching disaster characteristics, it was important to ensure that the information compiled was quantitative and comparable to other disasters. No disaster is exactly the same as any other, and therefore, each poses difficulties in comparing and contrasting. In order to allow for comparison analyses, the data collection focused on specific quantitative information, including number of deaths, number of injuries, and economic impact (in U.S. dollars) of the disaster. As discussed in the Literature Review, one of our goals was to develop a list of common traits among disasters. Research into specific historical examples of disasters the USN has responded to provide the basis for this analysis.

The EM-DAT database provides historical data on hurricanes (also referred to as cyclones), earthquakes, and accompanying tsunamis (EM-DAT, 2009). Other sources of information were obtained from FEMA (www.fema.gov) and the NOAA's National Weather Service (www.noaa.gov) websites.

2. U.S. Navy HADR Responses

The second phase of data collection was the actual responses that the USN has conducted to specified disasters. For simplicity, we looked at specific historical disasters that occurred within the past decade and that best represent assets in the USN response. In the project, we did not look for the reason that a certain asset was sent; rather, we strictly input the raw data of the assets that were sent. The USN HADR data collection answers which assets, specifically, the USN and MSC sent to respond to a specific disaster. We researched one disaster from each type (as specified in Table 4): hurricanes, tsunamis, and earthquakes.

Table 4. Disasters for HADR Response Analysis

Hurricane	Tsunami	Earthquake
Hurricane Katrina, 2005	Indian Ocean, 2004	Haiti, 2010

The disasters in Table 4 were decided upon based on the diversity of their classification in addition to their timing and high visibility. The tsunami was a dispersed disaster with moderate speed and onset that affected numerous nations; Katrina was a

moderate speed but was a domestic and localized disaster; whereas the Haiti earthquake was a sudden, localized, and international response. Moreover, the USN had a large role in each of these disasters, which makes it a good source for data collection.

Data collection for the USN response to the specified disasters was conducted through operational commander historical logs and archives where possible, other official government records as secondary sources, and civilian records as tertiary options. CCDRs and Functional Commanders maintain historical archives. A majority of data came from operational chronological records, Operational Orders (OPORD), Deployment Orders (DEPORD), and daily situational reports (SITREP). The goal of the archive investigation was to recreate the disaster response, focusing solely on the presence of USN and MSC assets in the relief efforts. The empirical data that we used to augment the tables includes asset type, time of arrival, duration of HADR mission, and missions performed during the HADR operations.

The data we collected in this phase of the project was critical for analyzing how the USN has responded in the past. By understanding which assets were sent in response to disaster, we were able to make recommendations as to which assets need to be sent in future HADR operations. We compare the USN's actual response to the concluded recommendations and provide insight into the savings and efficiency gains to the USN, if the recommendations were implemented.

3. USN and MSC Platform Characteristics

The final portion of data collection was concerned with characteristics of USN and MSC platforms. Studying the characteristics helped in determining which assets are best suited for HADR missions. We used the data to augment the USN and MSC capability chart. The chart looks at specified details that can be applied across all USN and MSC vessels. When collecting data, we looked at characteristics such as vessel speed, draft, lift capacity, onboard personnel, fresh water making capacity, storage space, and so forth. The compilation of data was essential in determining mission capability parameters for HADR missions to determine mission capability categorization for various platforms. Characteristics of platform data were drawn from public databases such as

Jane's Fighting Ships (Jane's, 2010), the online Navy Fact Files (www.navy.mil/navydata/fact.asp), and the MSC Handbook (MSC, 2010).

B. TABLE CONSTRUCTION

We tabulated data in a three-phrase process as data was collected. We generated the table topics before data collection took place to act as a guideline for research. We constructed a variety of tables and appendices containing data on disaster traits, standard mission requests, ship and aircraft characteristics, ship mission capabilities, and USN responses to specified disasters.

1. Disaster Traits

After we categorize the disasters, we included this information in the tables to display a variety of characteristics that were common among the disasters. These characteristics serve as a short summary of the effects of the disaster. Characteristics include number of deaths, number of injuries, homelessness, economic damage, and so forth.

The idea behind the disaster table was to determine common protocols that a local government and embassy may need in the event of a disaster. These common protocols are matched with USN asset capability to determine which assets are best suited to conduct desired missions.

2. USN HADR Responses

The second table consists of data collected from actual USN HADR responses. As indicated previously, the project delineated specific disasters to which the USN has responded. The purpose in compiling that information in a central table was to create a guide to demonstrate how the USN currently responds to disasters. The table lists each disaster, as indicated in Table 4, and inventories all USN and MSC assets that responded to the associated disaster. The specific platform was researched to determine when the asset arrived, the length of the activation process, how long each vessel was on station, what capabilities they brought to the area, and other amplifying information that may be beneficial to the analysis.

3. USN and MSC Platform Capabilities

The final table is a collection of data regarding the capabilities of every USN and MSC vessel. The goal was to determine which asset is best suited for conducting HADR operations. Due to operational constraints, it is impossible for the optimal ship to always respond, and therefore, the table indicates a pecking order for ships to respond as they become available. Studying the platform capability table will help commanders determine which vessels will be assigned to different missions. Specific data that is amalgamated into the table includes ship size characteristics, lift capacity, onboard personnel, onboard medical supplies, fresh water-making capability, and other characteristics related to the identified HADR missions.

C. DATA ANALYSIS

After we completed the construction of the tables, we conducted a detailed analysis of the compiled data. Our goal in performing that analysis was to find patterns in disaster traits and determine if there is much commonality between these various disasters. We expected that every disaster, although unique, possesses certain traits such as deaths, injuries, homelessness, and damaged infrastructure. Because the USN responds to mission requirements, we attempted in this project to develop a list of standard requirements for all disaster responses. By accepting as one of the parameters of this project that all major disasters have these properties, we will provide the basis for why it is important to classify USN and MSC platforms to respond to said requirements. As defined by FEMA, a disaster is set by the parameters that it caused either loss of human life or an economic loss of $1 million or more.

Beyond standard disaster missions, the goal of our project was to determine which USN and MSC assets are best matched to conduct these mission requirements. As stated previously, it is impossible to rely on the best assets to always be available; therefore, the project was designed to list ships in order of their effectiveness. In the event of a disaster, Fleet Commanders can use this guidance to determine which available ships will be optimal to respond to the affected area. Beyond determining which assets are best to respond to a given disaster, our goal for the project was to determine which, if any,

platforms offer little to zero assistance capability. Historically, the USN has sent assets that were in close proximity to a disaster but served no function once they arrived. The project reveals which assets will produce little to no assistance and, therefore, be a waste of resources to send. Knowing which assets should not be sent to assist in HADR operations can be just as beneficial to the USN as knowing which assets should be sent.

With mission capabilities applied to the various USN and MSC platforms, the project can be used as a tool in determining the overall effectiveness of historical HADR operations. By doing a comparison of what did happen versus what should have happened, we provide information to prove the effectiveness of HADR operations.

D. CONCLUSION AND RECOMMENDATIONS

The final process of this project was to define conclusions and summarize the project's main points. We drew the conclusions from our analysis, and they paint a clear picture as to the necessity of using the project in planning for future HADR operations. Ideally, the project will lead to changes in operational readiness. Currently, there is no standby ship designated for HADR operations. If this project proves to be substantial and beneficial then, ideally, these operational changes will be implemented in the future.

In addition to changing operational readiness, this project may be taken into consideration when it comes to fleet composition. Currently, there is no platform that is specifically designed to assist in disaster relief operations. If, in the future, the USN wants to take a more in-depth role in HADR operations, they may consider designing a platform around the mission. This project could be used as a guide to the requirements that the vessel would have to conduct in order to be an effective HADR vessel.

Our ultimate goal for this project was to bring to light several of the shortcomings that the USN has in its HADR operations and to characterize the standard "shape" of USN and MSC assistance in HADR efforts. By bringing to light these shortcomings, we hope to create more interest and, in turn, more concern and policy implementations that will make HADR operations more effective. By making the USN HADR operations more effective, the military can expect that more lives will be saved and devastated areas will be better recovered after a disaster strikes.

Following the conclusion, we end the project with further research ideas. The research ideas are related to gaps this project could not fill. The research gaps identify other areas of interest that will improve USN HADR operations. The goal is to have the interest in this research field continue for generations to come. The more research conducted in the HADR community, the more effective the process will become and the more lives will be saved.

E. SCOPE

1. Benefits

The results of this project can provide great benefits to the DoD. The project will potentially generate easy to understand matrices that will encompass historical data from past HADR operations and determine the value of USN and MSC assets to various disaster situations. The results will be beneficial to CCDRs who must decide the appropriate response to disasters as disasters occur in the AOR.

In the short term, the historical database will allow planners to see how operational decisions regarding HADR operations in the past have affected and influenced the relief and aid of affected areas. It will also provide the DoD with an understanding of whether or not a response was thought out and well planned or ad hoc. The lessons learned will be imperative to improving the future decisions that planners, CCDRs, and the DoD will have to make as disasters occur. The ship characteristic table will provide a guided reference for CCDRs to decide which assets they can, and should, use for HADR operations. The application of the matrix conclusions will allow decision-makers to conduct HADR operations that are more effective and cost-efficient.

In the long term, this project could affect fleet force structure. As the U.S. evolves in the 21st century, military operations will change, leading to a change in fleet force structure. As the U.S. moves to improve its foreign relations through the use of soft power, the USN will need to consider updating its assets. To meet the demands of future HADR operations, the USN may decide to provide dedicated assets on standby to assist when disasters occur. The matrices will provide insight as to which assets will be most advantageous to conduct a given mission. Currently, there are no USN or MSC platforms

that are designed around the HADR mission. In the future, the USN and MSC may wish to develop such a platform, and the results of this project can help to identify which characteristics and options a ship must have to successfully conduct the HADR mission.

2. Limitations

The limitations of this project lie in the subjective weighting factors that were applied to the matrices. The subjective factors, which were applied to various characteristics of different platforms, leave room for discrepancies. It is difficult to quantify how a certain characteristic, such as a specific crew size, provides more helpful features than another characteristic. Through the use of rigorous research, we implemented a weighting factor that best fits trends in the data and is as quantitative as possible while including as little qualitative assessment as possible; however, there is still ambiguity in the determinations.

Applicability could be another limitation of the project. The study was of USN and MSC assets. The uniqueness of USN and MSC assets is that they are limited to the waters in which they can navigate. While USN and MSC ships can only respond from a body of water, the primary place in which a disaster can impose damage to property and life is on land. A USN or MSC vessel can only assist those who are affected within a certain radius of a coastline. Because of this restriction, in the project, we analyze only disasters that fall into these restrictions and therefore exclude the humanitarian relief data from any other disaster. The restrictions on the research may skew the whole picture of what is needed to conduct a successful HADR operation.

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IV. EMPIRICAL DATA

A. DISASTER CHARACTERISTICS

This chapter defines common traits among disasters to which the USN and MSC have provided significant HADR support. Determining common disaster traits allows prediction of the missions the USN and MSC will face in support of HADR operations. A list of possible military missions allows prediction of which assets are best suited for deployment in support of HADR operations. Developing a list of common traits of disasters that elicit a USN and MSC response is important because it influences USN expectations, preparedness, and preparation for future HADR operations.

1. Disasters

In order to understand the missions requested of the USN and MSC in a disaster response, we must first understand some common characteristics of disasters. Each disaster contains some unique characteristics; however, there are standard characteristics among all disasters that might involve a USN response, which can be used to guide preparation and response structures. This section is an overview of the 2004 tsunami in the Indian Ocean, Hurricane Katrina, and the 2010 earthquake in Haiti. Each of these disasters prompted significant USN and MSC response. From the disaster overviews, we compiled a list of standard characteristics expected of disasters to which the USN and MSC will respond in the future (Pettit & Beresford, 2005).

a. Indian Ocean Tsunami, 2004

The Indian Ocean tsunami of 2004 was the result of an earthquake that measured magnitude 9.1 on the Richter scale—the fourth-largest earthquake worldwide since 1900 (Pickrell, 2005). Indonesia received most of the damage, with total destruction of many elements of infrastructure. The coastal highway on the island of Sumatra was completely destroyed, making many damaged areas completely inaccessible to land-based aid workers (Elleman, 2007). Waves generated by the earthquake struck

more than a dozen countries, ranging from Somalia in the west to Sri Lanka and India in the north to Indonesia in the southeast (Pickrell, 2005), as shown in Table 5.

Table 5. Effects of Indian Ocean Tsunami, 2004
(National Geographic, 2005; NGDC, 2011b; VanRooyen & Leaning, 2005)

Deaths	> 227,000
Injured	> 500,000
Missing	> 2,000,000 (summary of initial reports)
Displaced	> 1,500,000
In Indonesia, more than 25% of Aceh Province's villages were destroyed.	
Land transportation infrastructure was almost totally destroyed on many islands throughout the Indian Ocean.	
Indonesia's Aceh Province lost almost all elements of local communications infrastructure.	
Many islands lost all electric-power production capability.	
The U.S. pledged more than one third of a billion dollars to repair and replace roads and fresh water distribution systems alone.	

b. Hurricane Katrina, 2005

Hurricane Katrina struck Louisiana's coastline on August 29, 2005. At landfall, the storm was a Category 3 on the Saffir-Simpson hurricane scale, with winds greater than 125 mph (NOAA Public Affairs, 2007). Hurricane Katrina is recognized as the most costly hurricane ever to strike the United States, with an estimated $135 billion in damage to the Gulf Coast states (Plyer, 2010). The summarized resulting effects of the earthquake are shown in Table 6.

Table 6. Effects of Hurricane Katrina, 2005
(CRS, 2005; Louisiana Department of Health and Hospitals, 2006; NOAA Public Affairs, 2007; Plyer, 2010)

Deaths	>1,700
Injured	>2,000 in New Orleans alone
Missing	>12,000 reported, 135 still missing in August 2006
Displaced	>1,000,000 in gulf coast states
>Three million people without power; broken water mains left thousands without fresh water	
Flooding and closure of Louis Armstrong New Orleans International Airport	

>80% of New Orleans underwater on August 31, 2005
Major flooding and closure of many gulf coast highways
Considerable damage to the oil and fishing industries

c. Haiti Earthquake, 2010

We noted in our introduction that the earthquake that impacted Haiti on January 12, 2010, was horrendous and significant. For 35 seconds, the 7.0-magnitude earthquake rocked the small island and caused significant damage to the population and infrastructure (Aymat, 2010). Table 7 provides a summary of the effects of the earthquake.

Table 7. Effects of Haiti Earthquake, 2010
(Wooldridge, 2010)

Deaths	92,000–220,000 estimated
Injured	250,000
Missing	20,000
Displaced	1,100,000
Destruction of all five medical facilities around Port-au-Prince	
Destruction of Toussaint L'Ouverture International Airport	
Major damages to the Port-au-Prince seaport, rendering it unusable for immediate rescue operations	
Major damage to roadways by debris and destruction	
Considerable damage to communication infrastructure	

In addition to the commercial infrastructure damage, the mayor of Léogâne estimated that 90% of all buildings in Port-au-Prince were destroyed or deemed unusable as a result of the earthquake (Allen, 2010).

B. DERIVING STANDARD TRAITS FROM SPECIFIED DISASTERS

While each disaster presents a unique and complex situation, there are basic similarities between most disasters. In this project, we examined three disasters significant enough to warrant a HADR response from the DoD: the 2004 Indian Ocean earthquake/tsunami and its effect (primarily) on Indonesia, Hurricane Katrina, and the 2010 earthquake in Haiti. All three disasters caused a great number of deaths and

injuries, large population dispersion, and widespread destruction of infrastructure, including transportation means and facilities. Though diverse in classification (Apte, 2009), we found these disasters to have several common traits that are present in every significant disaster (EM-DAT, 2011). Of the many common traits between disasters, we limited our analysis to traits the USN and MSC can directly influence and considered only those outlined in Table 8.

Table 8. Basic Disaster Traits

Basic Disaster Traits
High number of deaths and injuries
Population dispersion, homelessness, and high number of missing persons
Facility destruction and loss of common goods such as fresh water supply
Increased demand for fresh water, food, and medical supplies
Need for medical personnel, facilities, and volunteers
Destruction of transportation infrastructures such as airports, seaports, railroads, and roads
High amounts of debris and destroyed buildings
Uncertainty in coastline with regards to navigation (coastal specific)

We acknowledge that all these traits may not be present in every disaster, but due to their coastal locations, and therefore generally higher populations and lower elevations, the disasters to which the USN and MSC respond will exhibit most of these traits. This list of specific traits helped to develop basic mission requests tasked to the USN and MSC in HADR operations.

C. LINKING DISASTER TRAITS TO MILITARY MISSIONS

The USN and MSC have a plethora of vessels with multimission capability. In order to understand which ships are better suited for HADR operations, we must first explore the different types of missions that commanders will be requested to conduct. In Chapter II, we defined the HADR request process. This process is key to understanding mission tasking for USN and MSC assets.

The recovery effort, postdisaster strike, is the responsibility of the affected nation’s embassy if the disaster is overseas, or the state’s governor, in the case of Hurricane Katrina. The embassy or state conducts an assessment of damages and

requests assistance from the DoS and DoD. In the DoD, once the regional CCDR receives capability requests from the DoS and the host nation embassy, the requested capabilities are converted to military missions and the Component Commanders are informed. Mission requests and ship capabilities merge once the request goes to the Component Commander. The Component Commander sends the request to the Fleet Commander. It is the responsibility of the Fleet Commander to link a mission request to a specific asset (ship class) and recommend specific assets for the response. The process emphasizes the importance of determining missions, linking missions to capabilities, and recommending assets for the response effort. By linking disaster traits to mission requests, the USN can determine which ships can conduct which missions.

To determine likely mission requests, we examined what the USN can do to help alleviate some of the burdens caused by disasters. Using common disaster traits derived in the previous section, we determined the mission, capability, and role a USN ship will play if assigned to a HADR operation. For example, we identified population dispersion, homelessness, and a high number of missing persons as a common trait in significant disasters. The USN can assist with finding missing persons by conducting search and rescue (SAR) missions. In addition to SAR missions, the USN can help the high number of homeless by conducting personnel transfers from unstable locations to stable locations. The best way a USN vessel can conduct SAR operations is to use an embarked helicopter with night vision capability and a communication suite. Personnel transfers are best done with a vessel designed to hold lots of personnel, capable of traveling at high speeds, and with a shallow draft. These are examples of how the military must convert disaster traits into capability requests. The linking of disaster traits and capability requests will help us to develop a list of standard missions that will be requested in HADR operations.

D. BASIC HADR MISSION REQUESTS

To create a basis for determining common mission requests, we connected common disaster traits with USN and MSC capabilities. There is a lot of overlap in capability requests between missions. For example, the capability to support lift operations is vital in conducting several missions, such as personnel transportation and

movement of cargo, food, and water. Table 9 provides a list of the most common mission requests the USN and MSC will receive.

Table 9. Standard HADR Mission Requests

Critical Missions	Aircraft support capability	
	Amphibious Landing Craft support	
	Search and Rescue (SAR)	
	Cargo Capacity	Dry goods
		Refrigerated goods
		Fresh water
		Roll On Roll Off (RORO)
		Fuel
		Self sufficiency
	Personnel transfer	
	Fresh water production	
	Personnel support for cleanup and recovery efforts	
	Berthing capability	
	Medical support	
Non-Critical Missions	Transit speed	
	Hydrographic survey	
	Salvage operations	
	Towing capability	

We broke the missions down into two categories: critical missions and non-critical missions. Critical missions are those that have a high impact on relief efforts, while non-critical missions do not commonly have a major impact on affected personnel or land-based facilities. Based on the common characteristics of disasters the USN and MSC respond to, the missions presented in Table 9 illustrate a core set of HADR missions for the USN and MSC in any response effort.

USN and MSC vessels are capable of performing several missions independently or concurrently. We have used a list of common disaster characteristics to identify common capability requests and missions that the USN and MSC may be tasked to provide during a relief effort. Identified capabilities of various assets can be correlated to

HADR mission requests to help determine which vessels are best suited to various aspects of HADR operations and which vessels have little to no capability to conduct HADR missions.

E. USN AND MSC ASSETS

1. U.S. Navy Vessels

Once a base of HADR mission requests and ship characteristics are identified, it then becomes necessary to match these characteristics to actual USN and MSC platforms. In order to fulfill all identified HADR missions, the USN must use a mix of multiple platforms. To determine which vessels are best suited from HADR missions, we must first understand the basic characteristics of USN and MSC vessels. Appendix A contains a breakdown of USN ship characteristics.

We could find no evidence of submarines actually contributing to any HADR operations, although two were present during Unified Assistance, the 2004 response to the earthquake and tsunami in the Indian Ocean (Lefebvre, 2005). Unified Assistance was unique in response structure because both a CSG and an ESG responded, each with an attached submarine (Elleman, 2007). As a result, we have excluded them from our analysis of capabilities.

The important takeaways from Appendix A are the characteristics that are relevant to HADR operations. We mentioned that HADR operations require a significant lift capability, which for a naval vessel means the ability to support the aircraft and landing craft that will be conducting lifts. Each ship and their HADR-related characteristics are broken down by platform, to include the various classes within the platform. The characteristics in this appendix are not all inclusive; they only portray the characteristics applicable to HADR operations.

2. MSC Vessels

Ownership plays a unique role in the way in which MSC vessels can be tasked and are on hand at any given time. As opposed to the USN, not all of MSC's vessels are government owned, nor are they all in a ready status. The following excerpts from the

MSC Handbook (MSC, 2010) provide an explanation of how MSC vessels are broken down:

> Naval Fleet Auxiliary Forces—PM1
>
> The ships of MSC's Naval Fleet Auxiliary Force (NFAF) are the supply lines to USN ships at sea. These ships provide virtually everything that navy ships need, including fuel, food, ordnance, spare parts, mail and other supplies. NFAF ships enable the navy fleet to remain at sea, on station and combat ready for extended periods of time. NFAF ships also conduct towing, rescue and salvage operations and provide floating medical facilities.
>
> All NFAF ships are Government-owned and Government-operated. The crews consist of civil service mariners. Some of the ships also have a small contingent of navy personnel aboard for operations support, supply coordination and helicopter operations. (MSC, 2010, p. 10)
>
> Special Mission—PM2
>
> The Special Mission Program has 26 ships that provide operating platforms and services for a wide variety of U.S. military and other U.S. Government missions. Most special mission ships are Government-owned and operated by civilian mariners who work for private companies under contract to MSC. Three ships have hybrid crews that combine uniformed Navy personnel with civil service mariners under the leadership of a U.S. Navy captain. One vessel, USNS Zeus, is Government-owned and crewed by MSC civil service mariners. Additionally, other PM2 ships are contracted to MSC and are crewed by U.S. civilian mariners who work for ship operating companies under contract to the government. (MSC, 2010, p. 11)
>
> Prepositioning—PM3
>
> MSC's Prepositioning Program is an essential element in the U.S. military's readiness strategy. Afloat prepositioning strategically places military equipment and supplies onboard ships located in key ocean areas to ensure rapid availability during a major theater war, a humanitarian operation or other contingency.
>
> Most MSC's prepositioning ships are able to discharge cargo pierside or while anchored offshore by using shallow-draft barges, called lighterage, that are carried aboard. This allows cargo to be ferried to shore in areas where ports are to operate in both developed and undeveloped areas of the world.

> Prepositioning ships include a combination of U.S. Government-owned ships, chartered U.S.-flagged ships and ships activated from the maritime Administration's Ready Reserve Force. All prepositioning ships are crewed by U.S. civilian mariners who work for ship operating companies under contract to the Government. (MSC, 2010, p. 12–13)
>
> Sealift—PM5
>
> MSC's Sealift Program provides high-quality, efficient and cost-effective ocean transportation for DOD and other federal agencies during peacetime and war. More than 90 percent of U.S. warfighters' equipment and supplies travels by sea. The program manages a mix of Government-owned and long-term-chartered dry cargo ships and tankers, as well as additional short-term or voyage-chartered ships. By law and policy, MSC must first look to the U.S.-flagged market to meet its sealift requirements. Government-owned ships are used only when suitable U.S.-flagged commercial ships and unavailable.
>
> Nearly all peacetime DOD cargo is carried by U.S.-flagged commercial ships. But during wartime or other contingencies, MSC has the flexibility to charter international ships to move cargo as needed. MSC can expand beyond this commercial capability by activating ships from its Government-owned surge fleet, including Ready Reserve Fleet (RRF) from the Maritime Administration (MARAD). (MSC, 2010, p. 14)

For classification purposes, we have divided MSC ships according to their Program (PM) designation. Appendix B is the MSC ship inventory and associated characteristics.

The most beneficial aspects of the MSC fleet are the ability to carry large amounts of cargo to the disaster area and the ability to provide significant medical support. Beyond cargo capacity, we will look at the benefits of MSC ships being self-sustaining, meaning capable of on-loading and off-loading cargo without the assistance of outside equipment. The characteristics listed in Appendix B are those which are pertinent to HADR operations.

3. Landing Craft

USN landing craft play a unique role in HADR operations. Landing craft serve as the waterborne link of transportation from amphibious platforms to shore. In HADR operations, they play the critical role of getting supplies, cargo, and personnel to and from the shoreline and supporting ships. While USN landing craft were not designed for HADR operations, they do serve as great tools in support of the mission. Appendix C

lays out pertinent characteristics that different landing craft bring to the HADR mission. The most applicable capabilities are lift capacity, draft, speed, and range. The information from Appendix C will be used to determine how landing craft can benefit the USN in its HADR operations.

4. Seaborne Aircraft

The final assets we analyzed for this project are seaborne aircraft. Seaborne aircraft include all helicopters and fixed-wing aircraft that can be utilized by USN and MSC ships. For the purpose of this project, we did not analyze any fixed-wing aircraft, with the exception of the MV-22 Osprey. The fixed-wing aircraft were eliminated from this project because of their lack of ability to assist in HADR operations. Military fixed-wing aircraft that play any significant role in HADR operations are characteristically too large to land onboard any USN or MSC vessel and, therefore, play no role in determining the usefulness of different vessels to HADR operations. Table 10 contains a list of all USN seaborne aircraft that can be used in conducting HADR operations.

Table 10. U.S. Navy Aircraft Characteristics
(Jane's, 2010)

Aircraft	Name	Op. Speed (knots)	Ceiling (ft)	Range (NM)	Operational Capabilities
SH-60B	Seahawk	145	10,000	450	Tactical aircraft for CG, DDG, and FFG. ASW, SAR, pax transfer
SH-60F	Seahawk	145	10,000	600	Provide close-in ASW protection
MH-60R	Seahawk	145	10,000	450	Replace the SH60B/F as the tactical aircraft for CG, DDG and FFG
MH-60S	Seahawk	154	10,000	420	Vertical replenishment, day/night SAR, special warfare support
HH-60H	Seahawk	147	10,000	500	Strike, Special Warfare support, and SAR
CH-46E	Sea Knight	137	8,500	180	Lift cap. Of 1 3-4.5 tons, carry 18 personnel
CH-53D	Sea Stallion	130	10,000	578	Assault, support and transport; can carry 50 pax, 24 litters or 14,000lbs
CH-53E	Super Stallion	150	10,000	580	Can carry up to 50 pax, 24 litters or 36,000lbs
MH-53E	Sea Dragon	150	10,000	1000	Similar to CH-53#, extended range, ASW support
AH-1W / AH-1Z	Super Cobra	135	10,000	317	Attack helo with air-to-air capability, FLIR
HH-1N / UH-1N / UH-1Y	Twin Huey	110	10,000	230	SAR, training, support and logistics for USN and USMC
MV-22 / CV-22	Osprey	255	25,000	400	Replacement for assault/support helo (CH-46E).

An aircraft's greatest role in HADR operations is serving as the connecting platform between land and supporting vessels, and conducting SAR missions. The most important information that we used in our analysis is an aircraft's lift capability, personnel transportation capability, and range. The information from Table 10 enabled our analysis of which vessels were better suited for different HADR missions.

F. DISASTER RESPONSES

Data on the USN and MSC responses to the Indian Ocean tsunami in 2004, on Hurricane Katrina in 2005, and on the Haiti earthquake in 2010 came from a variety of sources. Some sources that record ship response dates held conflicting information. When there was a conflict between a civilian source and an official military record, data from the official military record was used. If there was conflicting data between two civilian sources, an attempt was made to find additional sources to support *each* of the conflicting sources. Once three separate civilian sources corroborated the data, it was considered accurate and compiled for use in our disaster time lines.

1. Disaster Response Time Lines

Tables 11–13 display the USN and MSC responses to the Indian Ocean tsunami in 2004, Hurricane Katrina in 2005, and the Haiti earthquake in 2010 by detailing the names of the ships that responded and the time line of each response. Each table begins with the first day that a ship from either the USN or MSC was assigned to disaster response and ends with the last official day of the response effort. A cell is shaded light gray if the ship was ordered to respond, preparing to get underway, or en route to the disaster area on the corresponding day. A cell is dark gray if the ship was on location and responding to the disaster. A black cell indicates the day each ship was released from the HADR response for unrelated mission tasking.

Table 11. Time Line of the Indian Ocean Tsunami Response

(Elleman, 2007; Global Security, 2006a; Global Security, 2006b; Lefebvre, 2005; USPACOM, 2005)

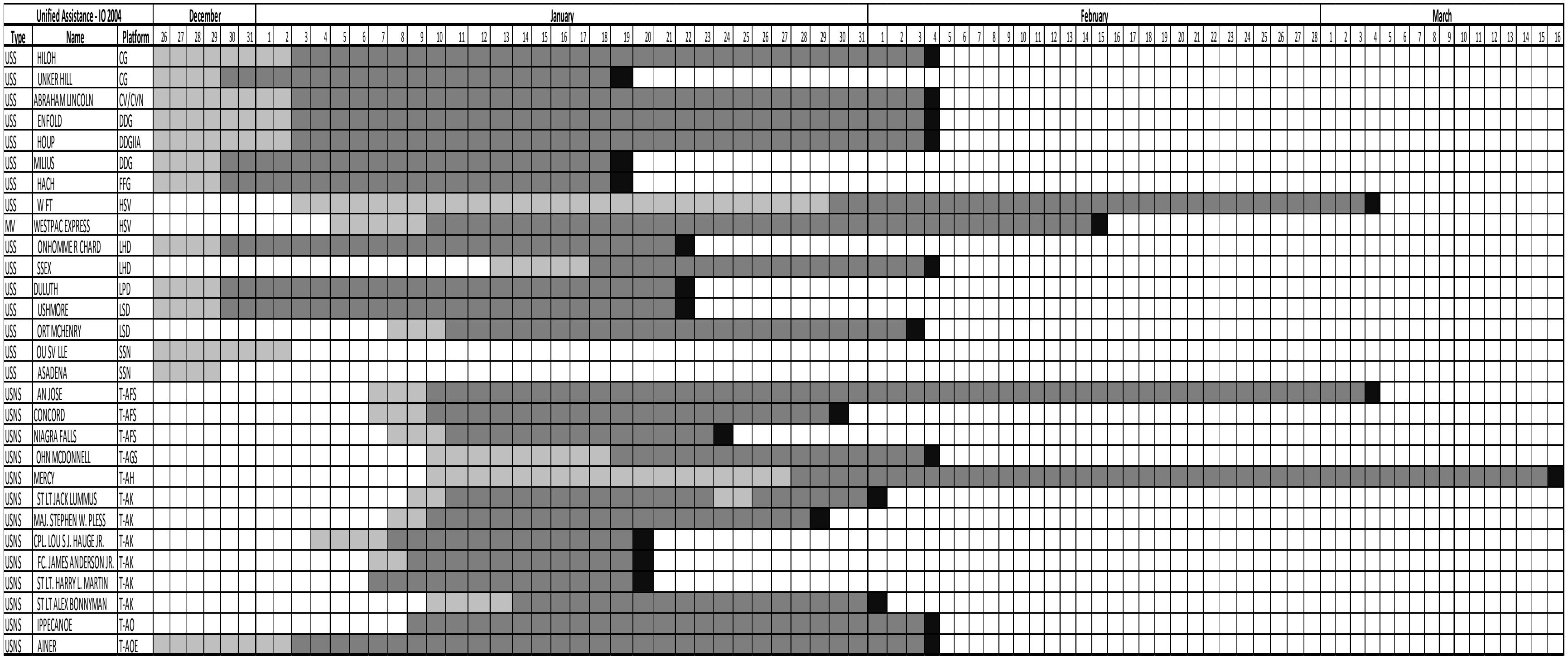


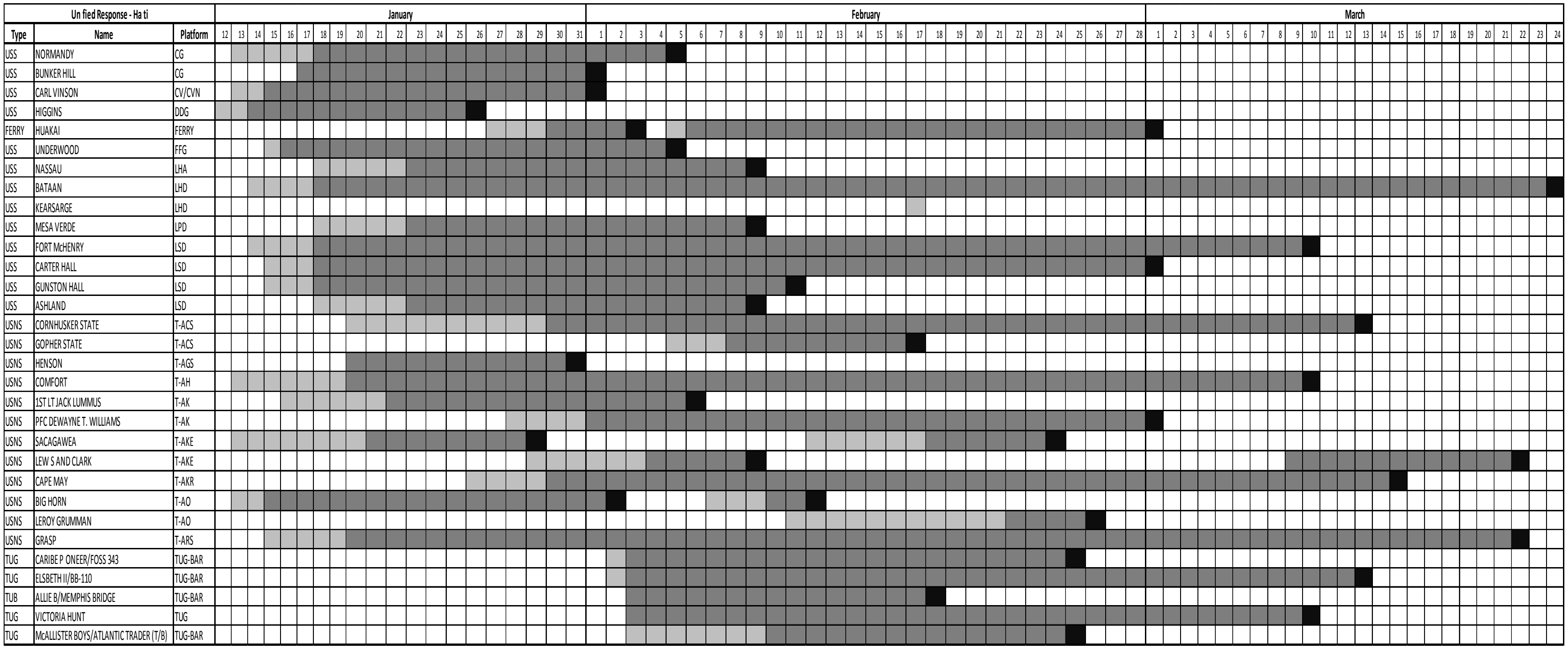
Table 12. Time Line of the Hurricane Katrina Response
(Inspector General, 2006; USNORTHCOM, 2005)

JTF - Katrina			AUGUST				SEPTEMBER																														OCTOBER							
Type	Name	Platform	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8
CRUISE	SENSATION	CRUISE																																										
CRUISE	HOLIDAY	CRUISE																																										
CRUISE	ECSTASY	CRUISE																																										
CRUISE	SCOTIA PRINCE	CRUISE																																										
USS	JOHN F KENNEDY	CV/CVN																																										
USS	HARRY S TRUMAN	CV/CVN																																										
USS	SWIFT	HSV																																										
USS	BATAAN	LHD																																										
USS	IWO JIMA	LHD																						H	R	R	R																
USS	SHREVEPORT	LPD																						H	R	R	R																
USS	TORTUGA	LSD																						H	R	R	R																
USS	WHIDBEY ISLAND	LSD																																										
USS	SCOUT	MCM/MHC																																										
USS	DEFENDER	MCM/MHC																																										
USS	GLADIATOR	MCM/MHC																																										
USS	PIONEER	MCM/MHC																																										
USS	AVENGER	MCM/MHC																																										
USS	CHIEF	MCM/MHC																																										
USS	FALCON	MCM/MHC																																										
USS	CORMORANT	MCM/MHC																																										
USS	BLACK HAWK	MCM/MHC																																										
USNS	COMFORT	T-AH																						H	H	R	R																
USNS	BELLATRIX	T-AKR																						H																			
USNS	ALTAIR	T-AKR																																										
USNS	PILLILAU	T-AKR																						H																			
USNS	BOB HOPE	T-AKR																																										
USNS	ARGOL	T-AKR																						H																			
USNS	POLLUX	T-AKR																						H																			
USNS	RED CLOUD	T-AKR																																										
USNS	CAPE VINCENT	T-AKR																																										
USNS	PATUXENT	T-AO																							R	R	R																
USNS	ARCTIC	T-AOE																																										
USNS	SUPPLY	T-AOE																																										
USNS	GRAPPLE	T-ARS																							R	R	R																

Note: 'H' indicates the ship got underway or was released from mission to avoid Hurricane Rita. 'R' indicates a ship was tasked with responding to Hurricane Rita. (All ships tasked to Rita were eventually retasked to Katrina.)

Table 13. Time Line of the Haiti Earthquake Response

(Buzby, 2010; Cook, 2010; Patrick 2010; Schulte, 2010; Seal, 2010; U.S. Fleet Forces Command [USFFC], 2010a, 2010b)



In the next chapter, we use the presence or absence of a ship at a disaster response to help analyze each response and to identify trends in USN and MSC disaster response efforts.

V. ANALYSIS

A. LINKING USN MISSIONS TO SHIP PLATFORMS

Linking missions to specific USN and MSC platforms provides a comparison of different vessels and their abilities to respond to disasters in different ways. In Chapter IV, we identified common disaster traits. We then developed mission categories linked to disaster traits. The last step is to link missions to USN and MSC platforms according to their capabilities. Linking characteristics of USN and MSC platforms to basic mission requests illustrates which USN and MSC are best suited to conduct HADR operations.

The link between missions and ship platform capabilities is made using a three-step classification system. The classification system is defined in Table 14.

Table 14. Capability Label Classifications

Empty Circle	○	The vessel has little no capability to conduct the specified mission
Half Filled Circle	◑	The vessel has some capability to conduct the specified mission
Filled Circle	●	The vessel is very capable in conducting the specified mission

1. Capability Determination

We had to determine each ship's capability to perform each mission related to HADR operations. It is difficult to place a quantitative value on how much better one class of ship conducts a mission than another class of ship. To avoid assignment of arbitrary quantitative values, a platform's capability is assigned one of three qualitative descriptions that are ordinally scaled with respect to each mission: little to no capability, some capability, very capable. In determining the capability for each ship, we had to set parameters around every mission. The parameters are defined in Table 15.

Table 15. Mission Capability Parameter Definitions

Category	Capability		Capability Defined
Critical Mission Capabilities	Aircraft support	○	No embarked helo, unable to support helicopter operations
		◑	Single helo embarked, able to support a majority of helo platforms
		●	Multiple helos embarked, able to sustain multiple flight operations simultaneously
	Landing Craft support	○	No ability to support landing craft
		◑	Some ability to support landing craft
		●	Landing craft embarked, able to load / off load cargo and store amphibious vehicles
	Search and Rescue	○	No embarked helo, unable to efficiently conduct SAR missions
		◑	Single embarked helo with communication equipment and night vision
		●	Multiple helos embarked with communication equipment and night vision
	Cargo Capacity: Dry goods, Refrigerated goods, Fresh water, Roll On Roll Off, Fuel, Self Sufficient	○	No ability to store good beyond current ship use
		◑	Ability to store some supplies beyond ship's use
		●	Ability to store and transfer mass amount of supplies
	Personnel transfer	○	No ability to support personnel transfer, slow speed vessel with deep draft
		◑	Ability to support personnel transfer for 15+ personnel
		●	High speed, shallow draft vessel with ability to transport 30+ personnel per voyage
	Fresh water production	○	no ability to produce freshwater beyond shipboard usage
		◑	Ability to produce and transfer >2,000 gallons per day beyond shipboard usage
		●	Able to produce and transfer > 5,000 gpd beyond shipboard usage
	Personnel support	○	Low crew number to support HADR mission (< 50 personnel)
		◑	Medium size crew which can support HADR mission (51 - 200 personnel)
		●	Large crew with ability to support HADR mission (> 200 personnel)
	Berthing capability	○	Little to no excess berthing or facilities (< 30 racks)
		◑	some excess berthing and facilities (31-50 racks)
		●	large number of excess berthing and facilities (> 50)
	Medical support	○	No ability to conduct impatient medical treatments, no Medical officer embarked
		◑	Some medical support onboard, ability to support minor medical procedures
		●	Medical officer embarked, ability to perform surgeries and hold several patients
Non-Dritical Mission capabilities	Transit speed	○	0-18 knots max speed
		◑	19-24 knots max speed
		●	25 + knots max speed
	Hydrographic survey	○	no ability to conduct hydrographic surveys
		◑	some ability to conduct hydrographic surveys, soundings and chart building
		●	Able to conduct hydrographic surveying, soundings and chart development
	Salvage Ops	○	No ability to conduct salvage operations
		◑	some ability for lift and salvage operations in shallow waters
		●	heavy lift and deep water salvage capable
	Towing	○	No ability to conduct towing operations
		◑	Ability to conduct emergency towing operations
		●	Designed to conduct push, pull, or alongside towing operations

Establishment of capability classifications allowed us to develop a full assessment of platforms for all missions. The parameters were compared to the characteristics listed in Appendices A and B. This comparison allowed us to assign each platform a score category for each mission. The end results display the full spectrum of a platform's

ability to conduct both critical and non-critical HADR missions. In the following sections, we break down each platform and its ability to conduct HADR missions based on USN and MSC ship characteristics and capability parameter definitions. Capability comparison tables for Landing Crafts and Seaborne Aircrafts can be seen in Appendix D.

2. USN Platforms

In Table 16, we have linked USN ship platforms to their capabilities to conduct HADR missions, within our defined capability parameters.

Table 16. USN Platforms to Capability Comparison

Missions to Platforms			Mission / Ship Characteristic																	
						Cargo Capacity														
			Aircraft support	Landing Craft support	Search and Rescue	Dry goods	Refrigerated goods	Fresh water	Roll On Roll Off	Fuel	Self Sufficient	Personnel transfer	Freshwater Production	Personnel support	Berthing capability	Medical support	Transit speed	Hydrographic survey	Salvage Ops	Towing
U.S. Navy		CVN (Nimitz)	●	○	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	●	○	○	○
U.S. Navy		CVN (Enterprise)	●	○	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	●	○	○	○
U.S. Navy	Amphibious Ships	LHD	●	●	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	◑	○	○	○
U.S. Navy	Amphibious Ships	LHA	●	●	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	◑	○	○	○
U.S. Navy	Amphibious Ships	LCC	◑	○	◑	◑	○	○	○	○	○	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LPD (San Antonio)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LPD (Austin)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LSD (Harpers Ferry)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LSD (Whidby Island)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	CRUDES	CG	◑	○	◑	○	○	○	○	○	○	◑	○	◑	○	○	●	○	○	◑
U.S. Navy	CRUDES	DDG (FLT I & II)	○	○	○	○	○	○	○	○	○	○	○	◑	○	○	●	○	○	◑
U.S. Navy	CRUDES	DDG (FLT IIA)	◑	○	◑	○	○	○	○	○	○	◑	○	◑	○	○	●	○	○	◑
U.S. Navy	CRUDES	Frigates	◑	○	◑	○	○	○	○	○	○	◑	○	◑	○	○	●	○	○	◑
U.S. Navy	Other	LCS (Freedom)	◑	○	◑	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	◑
U.S. Navy	Other	LCS (Independence)	◑	○	◑	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	◑
U.S. Navy	Other	PC	◑	○	◑	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	◑
U.S. Navy	Other	MCM	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●

Table 16 highlights the effectiveness of various USN platforms in their ability to conduct HADR missions. Table 16 shows different platforms broken down into the groups of Aircraft Carriers (CVN) Amphibious Ships (AMPHIBS), CRUDES (CG, DDG, and FFG), and Other (LCS, PC and MCM). The table clearly shows aircraft carriers and amphibious ships are the most capable across the widest range of HADR operations.

3. MSC Platforms

In Table 17, we have linked MSC ship platforms to their capabilities to conduct HADR missions, within our defined capability parameters.

Table 17. MSC Platforms to Capability Comparison

Missions to Platforms			Mission / Ship Characteristic																	
						Cargo Capacity														
			Aircraft support	Landing Craft support	Search and Rescue	Dry goods	Refrigerated goods	Fresh water	Roll On Roll Off	Fuel	Self Sufficient	Personnel transfer	Freshwater Production	Personnel support	Berthing capability	Medical support	Transit speed	Hydrographic survey	Salvage Ops	Towing
Military Sealift Command (MSC)	PM - 1	T-AOE	◑	○	○	●	●	●	○	●	◑	○	○	○	○	○	●	○	○	○
		T-AO	◑	○	○	●	●	●	○	●	◑	○	○	○	○	○	◑	○	○	○
		T-AE	◑	○	○	●	○	◑	○	●	◑	○	○	○	○	○	◑	○	○	○
		T-AKE	◑	○	○	●	●	◑	○	●	◑	○	○	○	○	○	◑	○	○	○
		T-ARS	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	●	●
		T-ATF	○	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	◑	●
		T-AH	◑	○	○	○	○	○	○	○	○	◑	●	●	●	●	○	○	○	○
	PM - 2	LCC	◑	○	◑	◑	○	○	○	○	○	◑	○	◑	◑	◑	◑	○	○	○
		AS	○	○	○	○	○	○	○	○	◑	○	○	◑	○	○	◑	○	○	◑
		T-AGOS	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	○	◑
		T-AGS (Survey)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●
		T-AGS (Nav)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		T-AGM	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		T-ARC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	○	◑
	PM - 3	LMSR	◑	○	○	●	●	●	●	●	●	○	◑	○	◑	○	◑	○	○	○
		MPS	◑	○	○	●	●	●	●	●	●	○	○	○	◑	○	◑	○	○	○
		MPF Container	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		T-AOT	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○
		T-AK (USAF)	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		T-AK (USA)	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		T-AVB	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		OPDS	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Break-Bulk	◑	○	○	◑	◑	◑	○	○	●	○	○	○	○	○	○	○	○	○
		HSV	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	○	○	○
	PM - 5	LMSR	◑	○	○	●	●	●	●	●	●	○	◑	○	◑	○	◑	○	○	○
		T-5	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○
		Common Use Tanker	○	○	○	◑	◑	●	○	●	◑	○	○	○	○	○	○	○	○	○
		Dry Cargo	○	○	○	●	●	◑	○	◑	●	○	○	○	○	○	○	○	○	○
	Ready Reserve Force	Fast Sealift Ship	◑	○	○	●	●	●	○	●	◑	○	○	○	○	○	●	○	○	○
		RO/RO ships	◑	○	○	●	●	●	●	●	●	○	◑	○	◑	○	◑	○	○	○
		Crane Ships	○	○	○	●	●	◑	○	◑	●	○	○	○	○	○	○	○	○	○
		Lighterage-aboard ships	○	○	○	●	●	◑	○	◑	●	○	○	○	○	○	○	○	○	○
		OPDT	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○
		Break-Bulk Ships	◑	○	○	◑	◑	◑	○	○	●	○	○	○	○	○	○	○	○	○
		Avaition Logistics Support	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○

B. OBSERVATIONS AND RECOMMENDATIONS

The Vessel to Capability Comparison table lays out an easy-to-understand comparison of vessels and their ability to conduct HADR operations. To highlight some key aspects of the table, we will discuss the advantages of some vessels while also acknowledging limitations of some vessels. For organizational purposes, we have broken the observations down into USN vessels and MSC vessels. The observations we have noted in this section will help in developing response recommendations for future HADR operations.

1. USN Observations

The overarching theme of USN support during HADR operations is its ability to transfer cargo via aircraft and landing craft and its ability to provide personnel support, berthing capacity, and medical support. While USN vessels are very capable at the transportation aspect of the HADR mission, they do lack in their ability to carry excess cargo, to include dry goods, refrigerated goods, fresh water, or roll-on-roll-off cargo.

One of the key takeaways for the USN observations is the high capability of amphibious vessels to conduct HADR missions. The amphibious vessels excel in their ability to conduct aircraft support, landing craft support, SAR, personnel transfers, berthing capability, and medical support. The big deck ships (CVN, LHD, and LHAs) are also extremely capable of providing personnel support, berthing capacity, and medical support. The table shows us that among USN vessels, the most capable and effective vessels for HADR mission are amphibious ships.

On the other side of the coin, we see the limits that CRUDES and other USN vessels have in conducting HADR operations. CRUDES vessels that have embarked helicopters (CG, DDG, FLT, IIA, and FFG) can provide some aircraft support, SAR capability, personnel transportations, and personnel support; however, those are the only critical missions that CRUDES vessels can conduct. The vessels described as "other" (LCS, PC, and MCM) are even more limited in conducting HADR missions and provide little to no assistance to the HADR mission.

2. MSC Observations

The biggest advantage of the MSC fleet is its ability to carry a high quantity of cargo to and from the disaster region. In Table 17, we see that a majority of full circles lie in the Cargo Capacity category. The MSC fleet is designed around providing supplies to the military, and therefore, it is of no surprise that the fleet is extremely capable in supporting the HADR mission by providing essential supplies to the affected area. In addition to its cargo capacity characteristic, MSC also has two hospital ships (T-AH) in its inventory. The hospital ships are probably the most recognized and desired ships during disaster relief operations because they are floating hospitals. The hospital ship provides a high level of medical support, along with a high capability to produce fresh water, berthing capacity, and personnel support.

While MSC is great at bringing supplies to the disaster region, it is limited in its ability to conduct other HADR missions. Very few MSC vessels have embarked helicopters, and they are, therefore, not very capable at conducting SAR missions and/or aircraft support. Another aspect of the MSC fleet is that a majority of the crew is composed of civilian mariners (CIVMAR) in a very small crew size. The small crews do not allow for a good level of personnel support during HADR missions. Beyond the hospital ships, the MSC fleet does not have a good capability to conduct medical support. Another setback for MSC in conducting HADR missions is its specialty vessels. For example, the T-AGS navigation ship is designed to provide navigation testing and support for USN submarines. Specialty mission vessels' characteristics essentially eliminate their ability to conduct HADR missions.

3. Response Recommendations

In this section, we identified which vessels are better suited to conduct HADR operations and we discussed which vessels have little to no capability to conduct HADR missions. Of USN vessels, we can clearly see that aircraft carriers and amphibious ships are the best ships at conducting HADR operations. At the same time, we can see little to no use for CRUDES and "other" ships during HADR missions. The limitation of USN ships is the ability to carry cargo, and therefore, there must be support from MSC to fulfill this critical HADR mission. The MSC fleet needs an assortment of cargo-carrying

vessels that can transport dry goods, refrigerated goods, and fresh water and that can be self-sustaining. Beyond cargo capacity, the use of the MSC hospital ships greatly benefits the USN's ability to conduct medical support in the affected area. It is to be noted that in the MSC fleet, there are several specialty ships that provide little to no HADR capability, and we recommend that these ships not be employed in the response plan.

C. ACTUAL USN AND MSC DISASTER RESPONSES

This project did not undertake the task of assigning quantitative values to USN and MSC assets' abilities to accomplish different HADR missions. We did not determine that one ship is twice as good or 33% better than another. We chose a qualitative categorization approach to allow for relative comparisons between overall response patterns, without forcing an arbitrary measurement of how much "better" one ship is than another. Our qualitative analysis of ships' capabilities considered two variables: the number of ships supporting a mission and the general categorization of capability they provide. This process enabled a big-picture view of response efforts, without getting hung up on details of capability levels.

The process we used to determine a ship's qualitative contribution to a given HADR mission was discussed in detail previously and is summarized in Figure 16 for reference in explaining the amalgamated nature of our analytical process.

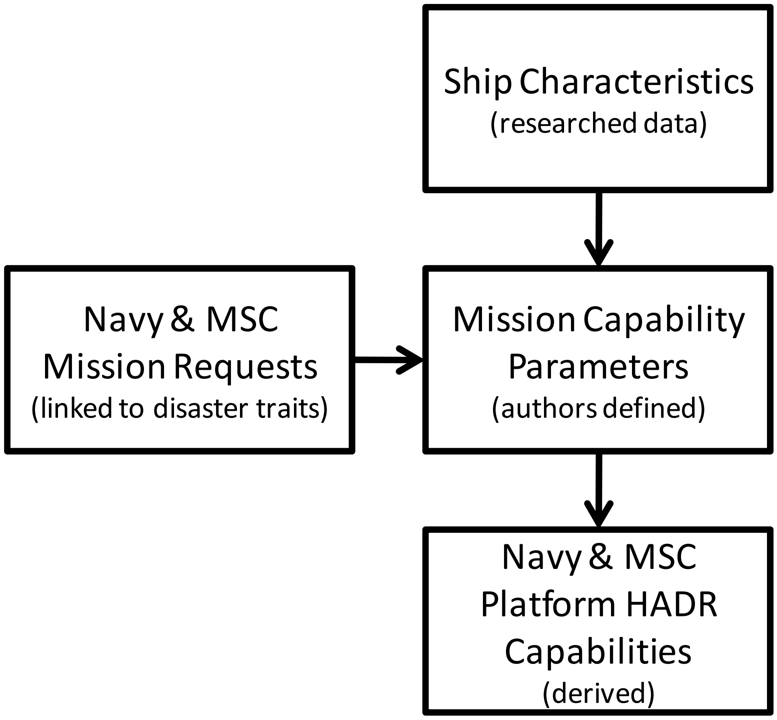


Figure 16. Process for Determining a Ship's Capability for a Mission

After determining USN and MSC platform capabilities for HADR missions, we used the disaster time lines from Tables 11–13 to characterize the responses to the three disasters. By combining time lines—which indicated a ship's presence at the disaster on a given day—and the qualitative values of the ship's mission capabilities, we were able to determine the response effort's qualitative contribution to each HADR mission.

Based on the mission capability parameters defined in Table 15, we assigned each ship a mission capability value of 0 if it possessed little to no capability of performing a mission, a value of 1 if it had some capability, and a value of 2 if it was very capable of performing a mission. Again, these values were not intended to indicate an exact measure of a vessel's capability; they merely indicate the ship's capability category for a given mission using an ordinal scale. A ship with a mission capability of 1 is not necessarily half as capable as a ship with a 2; it is merely less capable by such a degree that we placed it in a lower category. For example, there is a stark difference between a ship with no landing craft support capability (0) and a ship with some capability (1). There is less difference between some capability (1) and very capable (2), which may just be a matter of which landing craft types are supported.

By determining which ships were present at a disaster response on a given day and using the ships' mission capability values, we were able to determine a qualitative and relative degree of support provided to the different HADR missions. For every day of disaster response, we added all mission capability values from ships that were present on the specified day of the response to arrive at a *composite capability* value. For example, if only one ship was present at a disaster and it had a mission capability of 1 for Aircraft Support, then the mission's composite capability for that day was 1. If another ship with a mission capability score of 2 for Aircraft Support was present, then the mission's composite capability for that day was the sum of 3. We used composite capability for each day and each mission to analyze response patterns.

We have created time lines of each mission's composite capability levels for each disaster and have formatted the cells with the greatest contribution (by composite capability) to appear completely black and the cells with no contribution to appear completely white. The values that appear in the cells are the composite capabilities for given days.

1. Intraresponse Analyses

a. Response to the Indian Ocean Tsunami, 2004

Figure 17 displays the mission composite capabilities each day for each HADR mission over the entire response to the Indian Ocean tsunami in 2004.

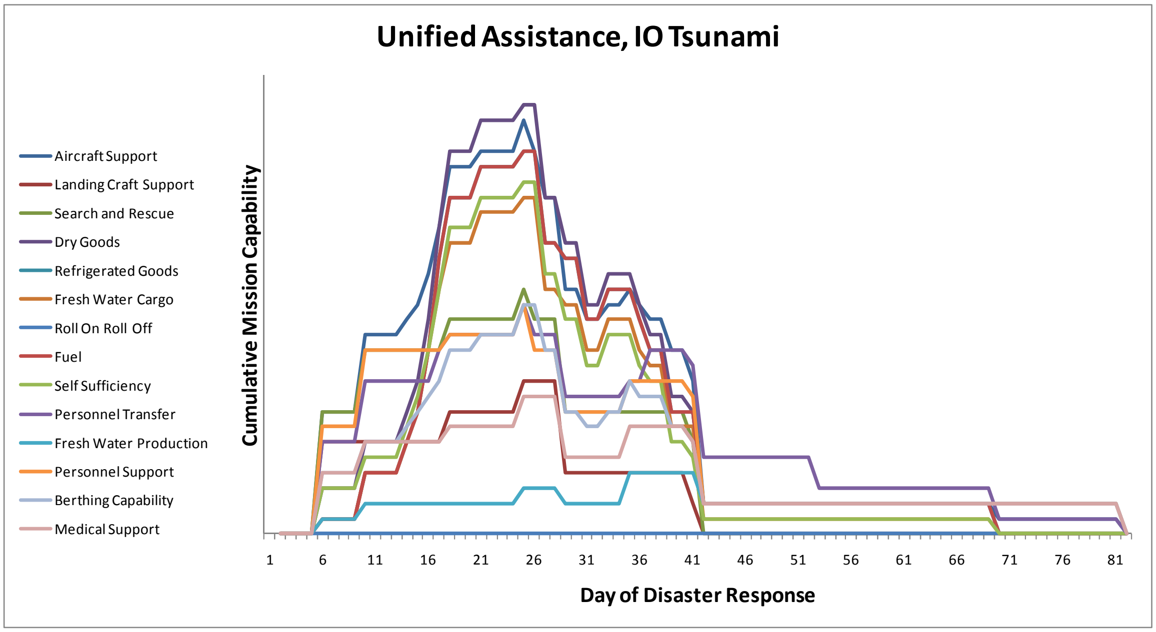


Figure 17. Mission Composite Capabilities: Indian Ocean Tsunami

The response to the Indian Ocean tsunami lasted 81 days. The first substantial increase in composite capability occurred about two weeks into the effort. Nearly all USN and MSC support for the response effort was completed by Day 41.

Table 18 shows that the peak of cumulative mission composite capability occurred on Day 24 of the response effort and the peak range of support occurred from Day 15 to Day 35. From greatest to least, the five missions that received the most support were dry goods cargo, aircraft support, fuel cargo, self-sufficient cargo handling, and fresh water cargo.

The response effort was executed using a CSG and ESG operating model, including the presence of one submarine with each group (Elleman, 2007). From the U.S. Navy's point of view, this was a uniquely international response effort covering a tremendous amount of territory. The USN and MSC responded all across the Indian Ocean but focused the bulk of their response efforts on western Indonesia (Lefebvre, 2005).

Table 18. Mission Composite Capability Time Line: I-Ocean Tsunami

IO Tsunami - 2004	December						January												
Critical Capabi ity	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13
Aircraft Support					8	8	8	8	13	13	13	13	14	15	17	20	24	24	24
Landing Craft Support					6	6	6	6	6	6	6	6	6	6	6	6	8	8	8
Search and Rescue					8	8	8	8	12	12	12	12	12	12	12	12	14	14	14
Dry Goods					3	3	3	3	6	6	6	6	8	10	14	20	25	25	25
Refrigerated Goods									4	4	4	4	6	8	12	18	22	22	22
Fresh Water Cargo									4	4	4	4	6	8	12	16	19	19	19
Roll On Roll Off																			
Fuel									4	4	4	4	6	8	12	18	22	22	22
Self Sufficiency					3	3	3	3	5	5	5	5	7	9	12	16	20	20	20
Personnel Transfer					6	6	6	6	10	10	10	10	10	10	10	12	13	13	13
Fresh Water Production					1	1	1	1	2	2	2	2	2	2	2	2	2	2	2
Personnel Support					7	7	7	7	12	12	12	12	12	12	12	12	13	13	13
Berthing Capabil ty					4	4	4	4	6	6	6	6	7	8	9	10	12	12	12
Medical Support					4	4	4	4	6	6	6	6	6	6	6	6	7	7	7
Cumulative Capabi ity					53	53	53	53	90	90	90	90	102	114	136	168	201	201	201

IO Tsunami - 2004	January																	
Critical Capabi ity	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aircraft Support	25	25	25	25	27	25	22	22	16	16	14	14	15	15	16	15	14	14
Landing Craft Support	8	8	8	8	10	10	10	10	4	4	4	4	4	4	4	4	4	4
Search and Rescue	14	14	14	14	16	14	14	14	8	8	8	8	8	8	8	8	8	8
Dry Goods	27	27	27	27	28	28	22	22	19	19	15	15	17	17	17	15	13	13
Refrigerated Goods	24	24	24	24	25	25	19	19	18	18	14	14	16	16	16	14	12	12
Fresh Water Cargo	21	21	21	21	22	22	16	16	15	15	12	12	14	14	14	12	11	11
Roll On Roll Off																		
Fuel	24	24	24	24	25	25	19	19	18	18	14	14	16	16	16	14	12	12
Self Sufficiency	22	22	22	22	23	23	17	17	14	14	11	11	13	13	13	11	10	10
Personnel Transfer	13	13	13	13	15	13	13	13	9	9	9	9	9	9	10	10	12	12
Fresh Water Production	2	2	2	2	3	3	3	3	2	2	2	2	2	2	4	4	4	4
Personnel Support	13	13	13	13	15	12	12	12	8	8	8	8	8	8	10	10	10	10
Berthing Capabil ty	13	13	13	13	15	15	12	12	8	8	7	7	8	8	10	9	9	9
Medical Support	7	7	7	7	9	9	9	9	5	5	5	5	5	5	7	7	7	7
Cumulative Capabi ity	213	213	213	213	233	224	188	188	144	144	123	123	135	135	145	133	126	126

IO Tsunami - 2004	February																											
Critical Capabi ity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Aircraft Support	12	12	10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Landing Craft Support	4	4	2																									
Search and Rescue	8	8	6																									
Dry Goods	9	9	8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Refrigerated Goods	8	8	8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Fresh Water Cargo	7	7	7																									
Roll On Roll Off																												
Fuel	8	8	8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Self Sufficiency	6	6	5																									
Personnel Transfer	12	12	11	5	5	5	5	5	5	5	5	5	5	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Fresh Water Production	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Personnel Support	10	10	9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Berthing Capabil ty	7	7	6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Medical Support	7	7	6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cumulative Capabi ity	102	102	90	23	23	23	23	23	23	23	23	23	23	23	21	21	21	21	21	21	21	21	21	21	21	21	21	21

IO Tsunami - 2004	March															
Critical Capabi ity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Aircraft Support	2	2	2													
Landing Craft Support																
Search and Rescue																
Dry Goods	2	2	2													
Refrigerated Goods	2	2	2													
Fresh Water Cargo																
Roll On Roll Off																
Fuel	2	2	2													
Self Sufficiency																
Personnel Transfer	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	
Fresh Water Production	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Personnel Support	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Berthing Capabil ty	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Medical Support	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Cumulative Capabi ity	21	21	21													

b. Response to Hurricane Katrina, 2005

Figure 18 displays the mission composite capabilities each day for each HADR mission over the entire response to Hurricane Katrina.

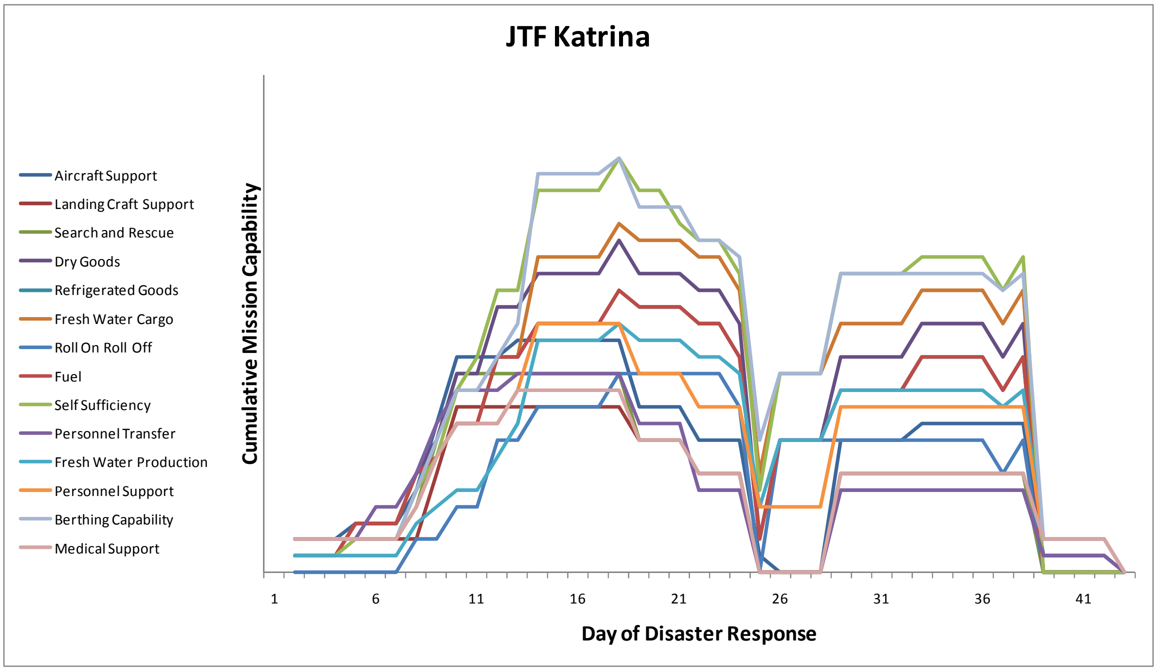


Figure 18. Mission Composite Capabilities: Hurricane Katrina

The response to Hurricane Katrina lasted 42 days. The first substantial increase in composite capability occurred about two weeks into the effort. Nearly all USN and MSC support for the response effort was complete by Day 38.

Table 19 shows that the peak of cumulative mission composite capacity of the response occurred on Day 17 of the response effort and the peak range of support occurred from Day 10 to Day 23. From greatest to least, the five missions that received greatest support were berthing capacity, self-sufficient cargo handling, fresh water cargo, dry goods cargo, and fuel cargo.

Hurricane Rita struck the Gulf Coast when the response to Katrina was about two-thirds complete, causing a number of ships to leave the Gulf of Mexico and go off tasking to avoid the storm. The presence, and therefore quick response, of the

Minesweepers stationed in Texas, combined with the need to corral oil rigs knocked adrift in both hurricanes, created an opportunity for good use of a platform we did not identify as particularly capable in HADR operations. The response to Hurricane Katrina was based on a JTF model and focused on southern Florida, where Katrina crossed the state, and also crossed Louisiana and Mississippi, which took the brunt of the force of the hurricane's landfall (USNORTHCOM, 2005). The USN and MSC response to Hurricane Katrina was quickly truncated rather than tapered down due to the large presence of DoS and NGO actors who were able to assume roles originally filled by the military and to a strong desire to push management of the disaster to a local level (CRS, 2005).

Table 19. Mission Composite Capability Time Line: Hurricane Katrina

JTF Katrina	AUGUST				SEPTEMBER																														OCTOBER							
Critical Capability	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8
Aircraft Support	2	2	2	3	3	3	5	9	13	13	13	14	14	14	14	14	14	10	10	10	8	8	8	1				8	8	8	8	9	9	9	9	9	9	1	1	1	1	
Landing Craft Support	2	2	2	2	2	2	2	6	10	10	10	10	10	10	10	10	10	8	8	8	6	6	6					6	6	6	6	6	6	6	6	6	6					
Search and Rescue	2	2	2	2	2	2	4	8	12	12	12	12	12	12	12	12	12	8	8	8	6	6	6					6	6	6	6	6	6	6	6	6	6					
Dry Goods				3	3	3	6	8	12	12	16	16	18	18	18	18	20	18	18	18	17	17	15	2	8	8	8	13	13	13	13	15	15	15	15	13	15					
Refrigerated Goods				3	3	3	6	7	9	9	13	13	15	15	15	15	17	16	16	16	15	15	13	2	8	8	8	11	11	11	11	13	13	13	13	11	13					
Fresh Water Cargo				3	3	3	6	7	9	9	13	13	19	19	19	19	21	20	20	20	19	19	17	6	12	12	12	15	15	15	15	17	17	17	17	15	17					
Roll On Roll Off							2	2	4	4	8	8	10	10	10	10	12	12	12	12	12	12	10		8	8	8	8	8	8	8	8	8	8	8	6	8					
Fuel				3	3	3	6	7	9	9	13	13	15	15	15	15	17	16	16	16	15	15	13	2	8	8	8	11	11	11	11	13	13	13	13	11	13					
Self Sufficiency				2	2	2	5	7	11	13	17	17	23	23	23	23	25	23	23	21	20	20	18	5	12	12	12	18	18	18	18	19	19	19	19	17	19					
Personnel Transfer	2	2	2	2	4	4	6	9	11	11	11	12	12	12	12	12	12	9	9	9	5	5	5					5	5	5	5	5	5	5	5	5	5	1	1	1	1	
Fresh Water Production	1	1	1	1	1	1	3	4	5	5	7	9	14	14	14	14	15	14	14	14	13	13	12	4	8	8	8	11	11	11	11	11	11	11	11	10	11	2	2	2	2	
Personnel Support	2	2	2	2	2	2	4	7	9	9	9	11	15	15	15	15	15	12	12	12	10	10	10	4	4	4	4	10	10	10	10	10	10	10	10	10	10	2	2	2	2	
Berthing Capability	2	2	2	2	2	2	5	8	11	11	13	15	24	24	24	24	25	22	22	22	20	20	19	8	12	12	12	18	18	18	18	18	18	18	18	17	18	2	2	2	2	
Medical Support	2	2	2	2	2	2	4	7	9	9	9	11	11	11	11	11	11	8	8	8	6	6	6					6	6	6	6	6	6	6	6	6	6	2	2	2	2	
Cumulative Capability	20	20	20	30	32	32	64	96	134	136	164	174	212	212	212	212	226	196	196	194	172	172	158	34	80	80	80	146	146	146	146	156	156	156	156	142	156					

c. Response to the Haiti Earthquake, 2010

Figure 19 displays the mission composite capabilities each day for each HADR mission over the entire response to the Haiti earthquake in 2010.

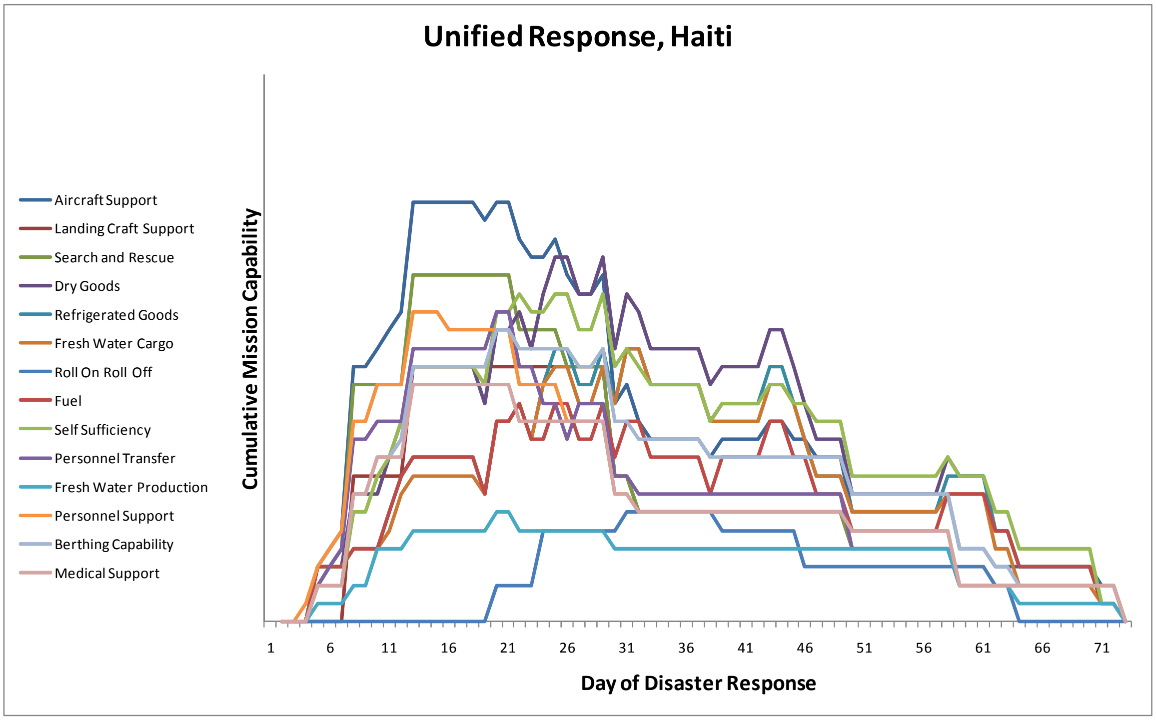


Figure 19. Mission Composite Capabilities: Haiti Earthquake

The response to the Haiti earthquake lasted 72 days. Nearly all USN and MSC support for the response effort was complete by Day 41. The first substantial increase in composite capability occurred about two weeks into the effort. USN and MSC support for the response effort tapered off gradually from the peak of the effort to the end of the official response.

Table 20 shows that the peak of cumulative mission composite capacity of the response occurred on Day 19 of the response effort and the peak range of support occurred from Day 12 to Day 28. From greatest to least, the five missions that received greatest support were aircraft support, dry goods cargo, search and rescue, self-sufficient cargo handling, and personnel support.

The response to the earthquake in Haiti contained significant international contribution and was executed using a JTF model (USFFC, 2010a).

Table 20. Mission Composite Capability Time Line: Haiti Earthquake

Haiti Earthquake - 2010	January																			
Cr tical Capability	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Aircraft Support				3	4	5	14	14	15	16	17	23	23	23	23	23	23	22	23	23
Landing Craft Support							8	8	8	8	8	14	14	14	14	14	14	14	14	14
Search and Rescue				2	3	4	13	13	13	13	13	19	19	19	19	19	19	19	19	19
Dry Goods				3	3	3	7	7	7	9	11	14	14	14	14	14	14	12	16	16
Refrigerated Goods				3	3	3	4	4	4	6	8	9	9	9	9	9	9	7	11	11
Fresh Water Cargo				3	3	3	4	4	4	5	7	8	8	8	8	8	8	7	11	11
Ro l On Ro l Off																			2	2
Fuel				3	3	3	4	4	4	6	8	9	9	9	9	9	9	7	11	11
Self Sufficiency				2	2	2	6	6	8	9	11	14	14	14	14	14	14	13	17	17
Personnel Transfer				2	3	4	10	10	11	11	11	15	15	15	15	15	15	15	17	17
Fresh Water Production				1	1	1	2	2	4	4	4	5	5	5	5	5	5	5	6	6
Personnel Support				3	4	5	11	11	13	13	13	17	17	17	16	16	16	16	16	16
Berthing Capability				2	2	2	7	7	9	9	10	14	14	14	14	14	14	14	16	16
Medical Support				2	2	2	7	7	9	9	9	13	13	13	13	13	13	13	13	13
Cumulative Capability				29	33	37	97	97	109	118	130	174	174	174	173	173	173	164	192	192

Haiti Earthquake - 2010	February																											
Cr tical Capability	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Aircraft Support	21	20	20	21	19	18	18	19	12	13	11	10	10	10	10	10	9	10	10	10	10	11	11	10	10	9	9	9
Landing Craft Support	14	14	14	14	14	14	14	14	8	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Search and Rescue	16	16	16	16	14	14	14	14	8	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Dry Goods	17	15	18	20	20	18	18	20	15	18	17	15	15	15	15	15	13	14	14	14	14	16	16	14	12	10	10	10
Refrigerated Goods	12	10	13	15	15	13	13	15	12	15	15	13	13	13	13	13	11	12	12	12	12	14	14	12	10	8	8	8
Fresh Water Cargo	12	10	13	14	14	12	12	14	12	15	15	13	13	13	13	13	11	11	11	11	11	13	13	12	10	8	8	8
Ro l On Ro l Off	2	2	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	3	3	3	3
Fuel	12	10	10	12	12	10	10	12	9	11	11	9	9	9	9	9	7	9	9	9	9	11	11	9	9	7	7	7
Self Sufficiency	18	17	17	18	18	16	16	18	14	15	14	13	13	13	13	13	11	12	12	12	12	13	13	12	12	11	11	11
Personnel Transfer	14	14	12	12	10	12	12	12	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Fresh Water Production	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Personnel Support	13	13	13	13	11	11	11	11	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Berthing Capability	15	15	15	15	15	14	14	15	11	11	10	10	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9
Medical Support	11	11	11	11	11	11	11	11	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Cumulative Capability	182	172	182	191	183	173	173	185	132	146	134	124	124	124	124	124	112	117	117	117	117	127	127	118	110	100	100	100

Haiti Earthquake - 2010	March																							
Cr tical Capability	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Aircraft Support	6	6	6	6	6	6	6	6	7	4	4	4	3	3	3	3	3	3	3	3	3	2	2	
Landing Craft Support	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Search and Rescue	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Dry Goods	7	7	7	7	7	7	7	7	9	8	8	8	5	5	3	3	3	3	3	3	3			
Refrigerated Goods	6	6	6	6	6	6	6	6	8	8	8	8	5	5	3	3	3	3	3	3	3	1	1	
Fresh Water Cargo	6	6	6	6	6	6	6	6	7	7	7	7	4	4	2	2	2	2	2	2	2	1	1	
Ro l On Ro l Off	3	3	3	3	3	3	3	3	3	3	3	3	2	2										
Fuel	5	5	5	5	5	5	5	5	7	7	7	7	5	5	3	3	3	3	3	3	3	1	1	
Self Sufficiency	8	8	8	8	8	8	8	8	9	8	8	8	6	6	4	4	4	4	4	4	4			
Personnel Transfer	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Fresh Water Production	4	4	4	4	4	4	4	4	4	2	2	2	2	2	1	1	1	1	1	1	1	1	1	
Personnel Support	5	5	5	5	5	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Berthing Capability	7	7	7	7	7	7	7	7	7	4	4	4	3	3	2	2	2	2	2	2	2	2	2	
Medical Support	5	5	5	5	5	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Cumulative Capability	74	74	74	74	74	74	74	74	83	61	61	61	45	45	31	31	31	31	31	31	31	20	20	

2. Cross-Response Analysis

We examined disaster responses to a tsunami, a hurricane, and an earthquake. We noticed a number of trends within the data. Many departures from trends were explained by the unique nature of a given disaster and the unique demands and opportunities commanders faced in structuring their responses.

a. Ship Composition Comparison

The fewest number of ships used in a disaster response was 29; the largest number was 34. Overall, USN and MSC ship volume per response was consistent. The USN always sent fewer ships than MSC provided. There were some departures from trends that are worth noting, however.

Submarines were present at only the tsunami response, and no record was found of either of the two present submarines contributing to an identified HADR mission (Elleman, 2007; Global Security, 2006a, 2006b; Lefebvre, 2005; USPACOM, 2005). Similarly, the mission capabilities where CGs, DDGs, and FFGs have some capability are duplicated or surpassed by assets that also excel at still more mission capabilities. We conclude that the absence of CGs, DDGs, and FFGs from a response effort would not significantly decrease the total capability provided to a given HADR mission area and that freeing these ships from HADR missions to which they are poorly suited would provide CCDRs with more available assets for other missions.

Hospital ships (T-AHs) are not kept in a ready status, and MSC only has two of them (MSC, 2010). As a result, there is a significant delay in the arrival of these ships on location to assist a response, as happened in the response to Katrina (USNORTHCOM, 2005), unless they happen to be underway in the area already, simply by chance, as happened in the response to the Haiti earthquake (Patrick, 2010).

Table 21 displays the number of ships used in each disaster response, broken down into groups of similarly capable ships. The disasters are listed in chronological order, displaying the change in the number of ships used from one disaster to the next, in each grouping.

Table 21. Ship Composition of Response: Comparison Between Disasters

Number of Ships Involved in Disaster Responses					
Category	**Unified Assistance**	Delta	**JTF Katrina**	Delta	**Unified Response**
SSN	2	-2	0		0
T-AH	1		1		1
CV/CVN	1	+1	2	-1	1
LHA/LHD	2		2	+1	3
MCM/MHC	0	+9	9	-9	0
CG/DDG/FFG	6	-6	0	+4	4
LPD/LSD	3		3	+2	5
MSC/Misc (w/o T-AH)	14	+3	17		17
USN	14	+2	16	-3	13
MSC/Contracted	15	+3	18		18
TOTAL SHIPS	29	+5	34	-3	31

b. Commonly Supported Missions

Dry Goods Cargo and Self-Sufficient Cargo Handling were among the top five most supported mission capabilities in all three disaster responses. Aircraft Support, Fuel Cargo and Fresh Water Cargo appeared in the top five for two responses each.

c. Unique Circumstances

Berthing Capacity (in the Katrina response) missions and Search and Rescue and Personnel Support missions (in the Haiti earthquake response) only received “top five” support once among all three disasters. MSC consistently provided ships to fill unforeseen needs, such as the rental of four entire cruise ships for berthing space during the Katrina response (Inspector General, 2006) and three integrated tug and barge platforms for downloading cargo when responding to the earthquake in Haiti (Schulte, 2010).

d. Peak Response and Peak Time Frames

Table 22 displays the cumulative mission composite capability for each disaster response, shading higher levels of mission support. Figure 20 graphs the same values versus the day of the response effort. Both Table 22 and Figure 20 show there is significantly more composite capacity support for HADR missions from the USN and MSC early in a mission response time line.

Table 22. Cumulative Mission Composite Capability Time Line

	Day of Disaster Response	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Cumulative	UA - IO Tsunami					53	53	53	53	90	90	90	90	102	114	136	168	201	201	201	213	213	213	213	233	224	188	188
	JTF Katrina	20	20	20	30	32	32	64	96	134	136	164	174	212	212	212	212	226	196	196	194	172	172	158	34	80	80	80
	UR - Ha ti				29	33	37	97	97	109	118	130	174	174	174	173	173	173	164	192	192	182	172	182	191	183	173	173
	AVERAGE				20	39	41	71	82	111	115	128	146	163	167	174	184	200	187	196	200	189	186	184	153	162	147	147

Day of Disaster Response	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
UA - IO Tsunami	144	144	123	123	135	135	145	133	126	126	102	102	90	23	23	23	23	23	23	23	23	23	23	23	21	21	21
JTF Katrina	146	146	146	146	156	156	156	156	142	156																	
UR - Ha ti	185	132	146	134	124	124	124	124	124	112	117	117	117	117	127	127	118	110	100	100	100	74	74	74	74	74	74
AVERAGE	158	141	138	134	138	138	142	138	131	131	76	76	72	50	50	75	71	67	62	62	62	49	49	49	48	48	48

Day of Disaster Response	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
UA - IO Tsunami	21	21	21	21	21	21	21	21	21	21	21	21	21	21													
JTF Katrina																											
UR - Ha ti	74	74	83	61	61	61	45	45	31	31	31	31	31	31	31	20	20										
AVERAGE	48	48	52	41	41	41	33	33	26	26	26	26	26	26	21	15	15										

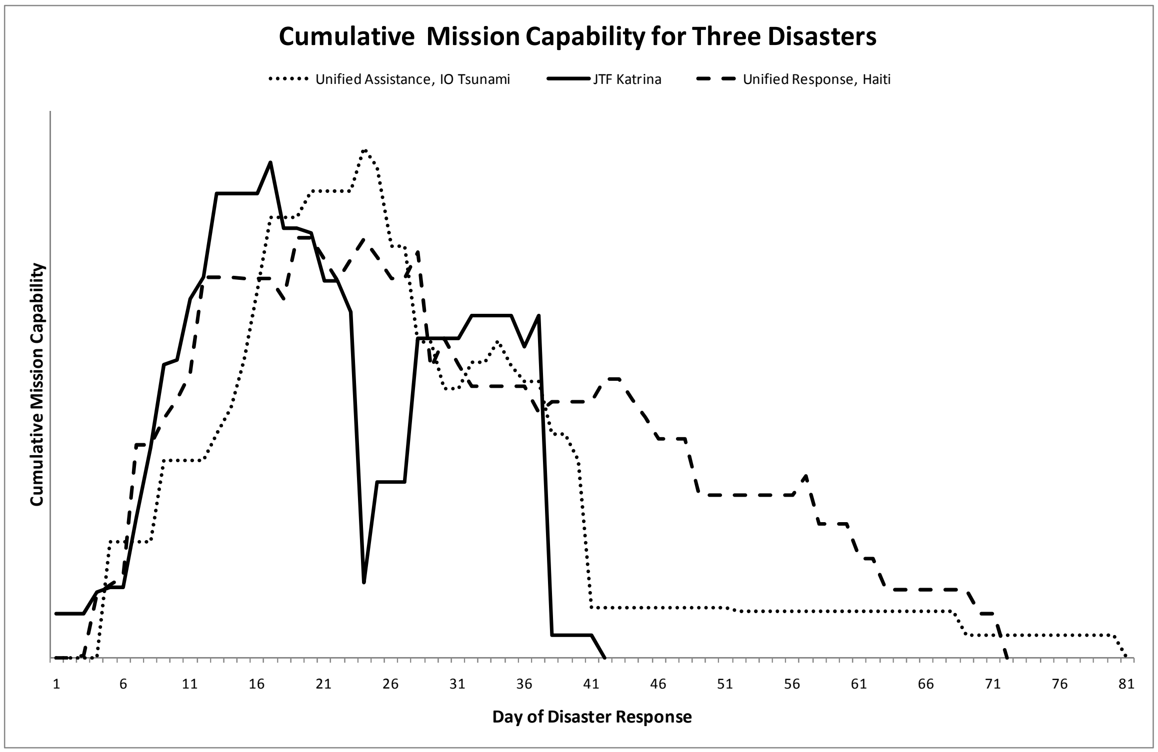


Figure 20. Cumulative Mission Capabilities for Three Disasters

Peak response efforts for each disaster occurred on Day 24 (Indian Ocean tsunami), Day 17 (Katrina), and Day 19 (Haiti earthquake). We identified that the beginning of peak ranges of support occurred on Days 15, 10, and 12. We identified that the endings to peak ranges of support occurred on Days 35, 23, and 28. A pattern emerges in the location of the starting of a peak support range, the peak, and the point where support levels decline significantly. Typically, support is ramped up in the first two weeks of a response and then begins to level out as it peaks, usually near the end of the third week. After peaking, it slowly tapers down until a point where there is a sudden decrease in support, usually at the end of the fourth week of the response effort. Despite the dramatic drop in support after the peak range, the overall support level decreases much more gradually than the increase seen in ramp-up.

3. Validation of Pettit and Beresford's Model of Emergency Recovery

Figure 20 and Table 22 provide an indication that there is a typical "shape" of USN and MSC disaster responses. To create a smoother picture of this shape, we averaged the cumulative mission composite capability provided across all HADR mission areas for each day, for each disaster. We graphed these values and drew a free-hand curve to represent the basic shape of the relationship between mission capability and time in a USN and MSC disaster response effort (see Figure 21).

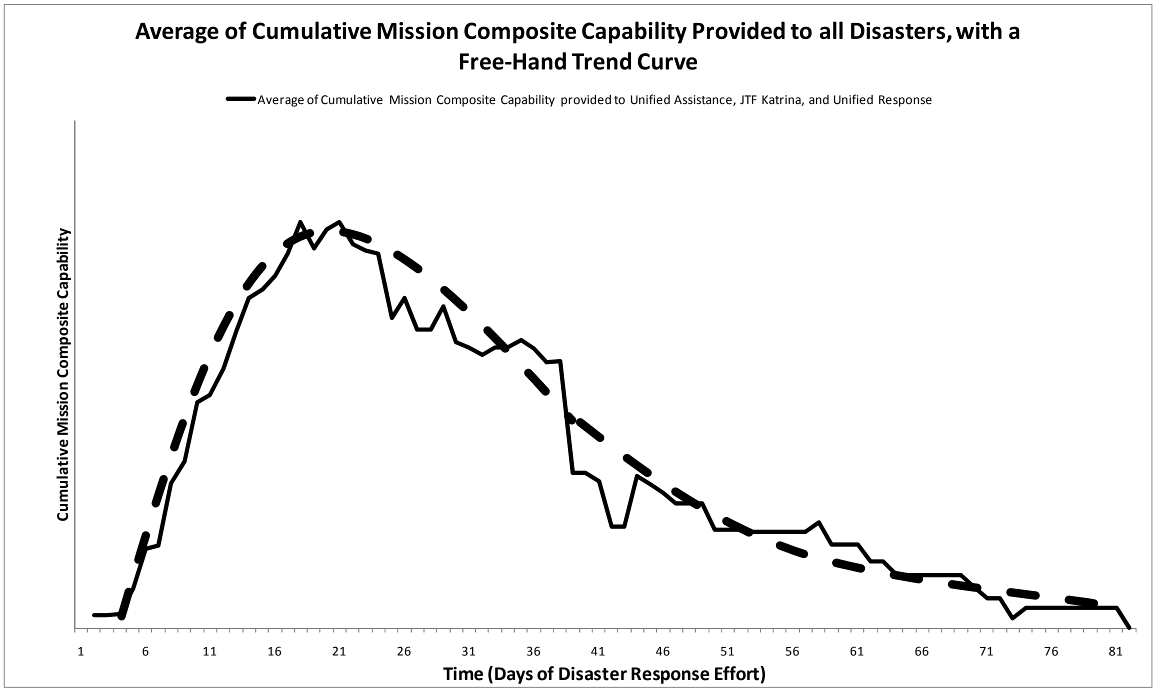


Figure 21. General "Shape" of USN and MSC Disaster Response Efforts

The general shape of USN and MSC support of HADR missions in the responses to the Indian Ocean tsunami, Hurricane Katrina, and the Haiti earthquake in 2010 is easy to recognize. Although the project objective was not to validate the Pettit and Beresford (2005) model, it is an exact match for their proposed model of emergency recovery. A more complete overlay of Pettit and Beresford's (2005) model, with all elements relevant to USN and MSC response, is shown with the average of cumulative mission composite capabilities for our three disasters in Figure 22.

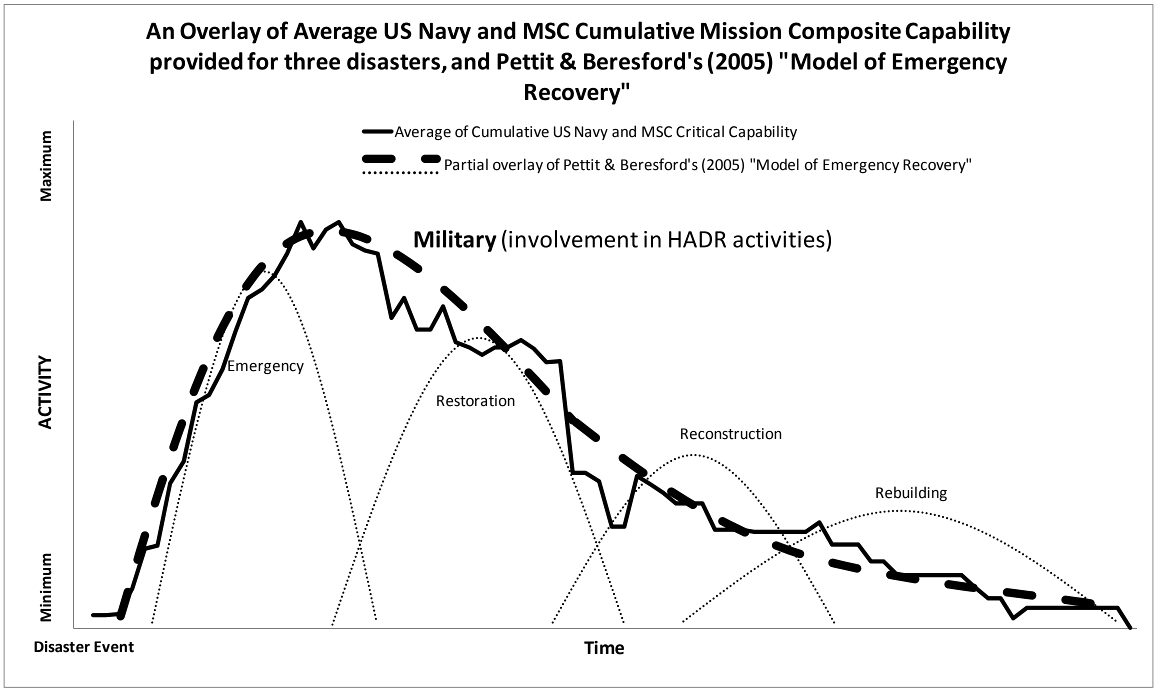


Figure 22. An Overlay of Average U.S. Navy and MSC Cumulative Mission Capabilities Provided for Three Disasters and Part of Pettit and Beresford's (2005) "Model of Emergency Recovery"

VI. CONCLUSION

A. INCREASING NUMBER OF DISASTERS AND HADR OPERATIONS

Since the 1970s, there has been a marked increase in the number of deaths and disasters reported each year (EM-DAT, 2011). *A Cooperative Strategy for 21st Century Seapower* (DoN, 2007) links seapower to other elements of national strength and designates HADR operations to be equally important as combat operations. It also recognizes that a measurable majority of the world's population lives near coastlines (DoN, 2007). Destruction from hurricanes and tsunamis will always be most devastating along coastlines, due to the nature of these disasters, and many coastlines are formed along tectonic plate fault lines, which increases the chance that the USN and MSC will need to respond to tsunamis, hurricanes, and earthquakes.

B. CONSISTENT RESPONSE PATTERNS

Evaluating responses to a tsunami, a hurricane, and an earthquake yielded surprising consistency in USN and MSC responses. One hospital ship was used in each response. More MSC than USN assets were employed in each response. The number of amphibious assets employed was usually much larger than CRUDES, and the one occurrence where it was not larger is explained by the strict CSG and ESG structure used for the response. The number of ships used in each response varied little. The peak levels of mission capabilities did not vary greatly from one response to another. Typically, USN and MSC mission support started peaking two weeks into a response effort, fully peaked at three weeks, then rapidly declined, and finally tapered off until the end of an operation.

C. PLATFORM CONCLUSIONS

1. Platform Considerations

One of the goals of this project has been to define platform capability in conducting HADR operations. Tables 16 and 17 can be used as a tool in determining which vessels are the most adaptable in conducting HADR missions and what

combination of vessels are required to cover the full range of missions that HADR operations require. The analysis of our observations has shown that amphibious vessels are the best platforms to conduct HADR operations. The analysis has also shown the limitations that the USN vessels have in conducting the full range of HADR missions. Based on these observations, we conclude that those vessels that can conduct lift operations and provide medical and personnel support are best suited, while those vessels that are limited in their ability to conduct those missions are not well suited for HADR missions. There is much debate about the usefulness and need for amphibious ships in the future, and we believe that they serve a vital role in HADR operations that cannot be filled by other vessels.

2. Task Force Composition and Force Structure

The USN fleet is comprised of CSGs, ESGs, ARGs, and SSGs. The structure of these groups is effective in conducting major campaign operations but tends to be overkill for HADR operations. In the case of Unified Assistance, the USN deployed full ESGs, which resulted in tasking several CRUDES vessels to support the HADR mission. As discussed earlier, CRUDES vessels provide little assistance in HADR operations and, therefore, were being underutilized for their entire time on station. For future HADR operations, it would be advisable for the CCDRs to form a HADR Task Force comprised of amphibious vessels and MSC vessels. A Task Force should be able to conduct all required HADR missions with only the most effective platforms.

3. Design of HADR Vessel

Due to the increase in worldwide disasters and the increased desired to conduct HADR missions in the Navy, it may be beneficial to design and develop a platform that is centered on HADR operations. The project could serve as a useful tool in defining the parameters in which the vessel should be able to perform. The critical capabilities defined in this project could serve as building blocks in the concept design of the vessel.

D. SPECIAL CONSIDERATIONS AND CIRCUMSTANCES

The response to Hurricane Katrina provides an obvious caveat to our proposed force structure for HADR operations. Commanders must recognize unique situations and make use of the assets on hand. The presence of nine MCM and MHC platforms in the Gulf of Mexico provided commanders with immediately available assets that might not have been ideal for typical disaster response missions but that were capable of an atypical mission: locating and corralling drifting oil rigs (USNORTHCOM, 2005). Another special consideration in HADR operations is the use of nuclear-reactor-qualified personnel in gaining stability to the affected reactors in Japan after the tsunami on March 11, 2011. In this incident, we have an example of a very unique situation in which the USN can play a vital role in assisting the affected population.

E. FUTURE RESEARCH RECOMMENDATIONS

Limits to our research and its applicability indicate a number of areas in which further research is recommended, as summarized in Table 23.

Table 23. Future Research Recommendations

Determine a quantitative method of comparing the utility of one ship to another in HADR operations
Conduct a more in-depth analysis of these three disasters to determine exactly which HADR mission areas each type of asset supported, and conduct a capability analysis at this level
Construct an optimization model based on ship characteristics to determine the best composition of a JTF for disaster relief. Suggested maximum constraints (or minimization goals) would be asset cost (perhaps by daily fuel burn cost), total number of ships assigned, and number of personnel assigned. Suggested minimum constraints could include operating rooms, berthing space, and cumulative pounds of airlift capacity. Decision variables would include the number of ships of each class to include in the JTF.

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APPENDIX A

Observed USN Ship Characteristics:

Ship Type
Abbreviation
Class Name
Number of vessels in class
Hull numbers
Location (home port)
Size:
- Length (ft)
- Beam (ft)
- Draft (ft)
- Displacement (metric tons)

Max Speed (knots)
Crew Size:
- Ship's Company
- Air Wing detachment
- Marine Detachment

Aircraft Support: (number of aircraft that the vessel has embarked and/or can support)
- Helicopters:
  - CH-46 Sea Knight
  - CH-53 Sea Stallion
  - UH-1N Huey
  - AH-1W Super Cobra
  - HH-60H
  - SH-60F Seahawk
  - SH-60B Seahawk
  - MH-60
- Fixed-Wing:
  - AV-8B Harrier
  - MV-22 Osprey
  - F/A-18 Hornet
  - EA-6B Prowler
  - E-2C Hawkeye

Landing Craft: (number of Landing Craft that the vessel has embarked and/or can support)
- LCAC / LCU
- AAV

References: Jane's, 2010; Navy Fact File, 2011; MSC Handbook, 2011.

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APPENDIX B

Observed MSC Ship Characteristics:

Ship Type
Class type
Number in class
Hull numbers
Location (home port)
Size:
- Length (ft)
- Beam (ft)
- Draft (ft)
- Displacement (metric tons)

Max Speed (knots)
Crew Size:
- Civil Service
- Military Detachment

Cargo Capability:
- Fuel (bbls)
- Ammunition (tons)
- Vehicles (sq ft)
- Dry Cargo:
  - Tons
  - Pallets
- Refrigerated stores:
  - Tons
  - Frozen (pallets)
  - Chill (pallets)
- Water (gal)

Operational Capabilities (ship characteristics that are relevant to the HADR operations)

References: Jane's, 2010; Navy Fact File, 2011; MSC Handbook, 2011.

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APPENDIX C

Table C1. Landing Craft Characteristics
(Jane's, 2010)

Vessel	abrev	Class	Size					Max Speed (knots)	Range (miles) with payload	Crew	Load (tons)		Military Lift
			Length (ft)	Beam (ft)	Draft (ft)	Displacement (tons) Light	Displacement (tons) Full Load				normal	overload	
Landing Craft, Air Cushioned	LCAC		87	47	2.9 / 0 3	87.2	170-182	40+	200 @ 40 kts 300 @ 35 kts	5	60	75	* 23 troops
Landing Craft, Utility	LCU	1610, 1627, 1646	135	29	8.5	200	375	11	1200 @ 8 kts	14	170	N/A	* M1A1 tanks (3), LAVs (10 or 400+ troops; 125 tons cargo
Landing Craft, Mechanized	LCM	8	73.7	21	5.2	N/A	105	12	190 @ 9 kts	5	180	N/A	* M48 (1) or M60 tank (1) or 200 troops
Landing Craft, Mechanized	LCM	6	56.2	14	4	N/A	64	9	130 @ 9kts	5	34	N/A	* 80 troops

APPENDIX D

Table D1. Landing Craft Comparison Table

Missions to Platforms		Aircraft support	Landing Craft support	Search and Rescue	Cargo Capacity: Dry goods	Cargo Capacity: Refrigerated goods	Cargo Capacity: Fresh water	Cargo Capacity: Roll On Roll Off	Cargo Capacity: Fuel	Cargo Capacity: Self Sufficient	Personnel transfer	Freshwater Production	Personnel support	Berthing capability	Medical support	Transit speed	Hydrographic survey	Salvage Ops	Towing
Landing Craft	LCAC	○	○	○	○	○	○	◑	○	○	●	○	○	○	○	●	○	○	○
	LCU	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○
	LCM (8)	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○
	LCM (6)	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○

(Column group heading: Mission / Ship Characteristic)

Table D2. Seaborne Aircraft Comparison Table

Capability / Aircraft		Lift	Personnel Transport	Range	Vertical Replinishment	SAR	Speed
Seaborne Aircraft	SH-60B	◑	◑	◑	◑	●	◑
	SH-60F	◑	○	◑	◑	●	◑
	MH-60R	◑	◑	◑	◑	◑	◑
	MH-60S	◑	◑	◑	◑	●	◑
	HH-60H	◑	◑	◑	◑	●	◑
	CH-46E	●	●	◑	◑	◑	◑
	CH-53D	●	●	◑	◑	○	◑
	CH-53E	●	●	◑	◑	○	◑
	MH-53E	●	●	◑	◑	○	◑
	AH-1W / AH-1Z	○	○	◑	○	◑	◑
	HH-1N / UH-1N / UH-1Y	○	◑	◑	○	●	◑
	MV-22 / CV-22	●	●	●	○	○	●

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Contract Management

- Commodity Sourcing Strategies
- Contracting Government Procurement Functions
- Contractors in 21st-century Combat Zone
- Joint Contingency Contracting
- Model for Optimizing Contingency Contracting, Planning and Execution
- Navy Contract Writing Guide
- Past Performance in Source Selection
- Strategic Contingency Contracting
- Transforming DoD Contract Closeout
- USAF Energy Savings Performance Contracts
- USAF IT Commodity Council
- USMC Contingency Contracting

Financial Management

- Acquisitions via Leasing: MPS case

- Budget Scoring
- Budgeting for Capabilities-based Planning
- Capital Budgeting for the DoD
- Energy Saving Contracts/DoD Mobile Assets
- Financing DoD Budget via PPPs
- Lessons from Private Sector Capital Budgeting for DoD Acquisition Budgeting Reform
- PPPs and Government Financing
- ROI of Information Warfare Systems
- Special Termination Liability in MDAPs
- Strategic Sourcing
- Transaction Cost Economics (TCE) to Improve Cost Estimates

Human Resources

- Indefinite Reenlistment
- Individual Augmentation
- Learning Management Systems
- Moral Conduct Waivers and First-term Attrition
- Retention
- The Navy's Selective Reenlistment Bonus (SRB) Management System
- Tuition Assistance

Logistics Management

- Analysis of LAV Depot Maintenance
- Army LOG MOD
- ASDS Product Support Analysis
- Cold-chain Logistics
- Contractors Supporting Military Operations
- Diffusion/Variability on Vendor Performance Evaluation
- Evolutionary Acquisition
- Lean Six Sigma to Reduce Costs and Improve Readiness
- Naval Aviation Maintenance and Process Improvement (2)
- Optimizing CIWS Lifecycle Support (LCS)

- Outsourcing the Pearl Harbor MK-48 Intermediate Maintenance Activity
- Pallet Management System
- PBL (4)
- Privatization-NOSL/NAWCI
- RFID (6)
- Risk Analysis for Performance-based Logistics
- R-TOC AEGIS Microwave Power Tubes
- Sense-and-Respond Logistics Network
- Strategic Sourcing

Program Management

- Building Collaborative Capacity
- Business Process Reengineering (BPR) for LCS Mission Module Acquisition
- Collaborative IT Tools Leveraging Competence
- Contractor vs. Organic Support
- Knowledge, Responsibilities and Decision Rights in MDAPs
- KVA Applied to AEGIS and SSDS
- Managing the Service Supply Chain
- Measuring Uncertainty in Earned Value
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